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ORIGINAL ARTICLES.

I.—Further Notes on the Tertiary Entomostraca of England, with Special Reference to those from the London Clay.

By Professor T. Rupert Jones, F.R.S., and C. Davies Sherborn, F.G.S.

(PLATE XI.)

THE Tertiary Entomostraca (Ostracoda) of England, at first treated of in a monograph for the Palæontographical Society in 1856, were revised in the Geological Magazine, 1870, pp. 155–159. The researches of G. O. Sars and G. S. Brady, elucidating the relationships of the genera and species, gave effect in a great degree to that revision; and their continued labours have further helped us.

Since the publication of the Revision, fifteen years ago, besides there being some additional corrections to be noticed, several new species have come to hand, late research in the fossiliferous deposits of Tertiary age having enabled our friends to add to the collections we have made for ourselves, so that the known English Tertiary forms are now nearly eighty in number. The British Post-Tertiary species are still more numerous.[1]

We therefore offer these "Further Notes" as of interest to workers on Fossil Ostracoda.

Besides new species, those requiring some remarks as to new occurrence or corrected nomenclature are noticed in this communication. We especially take this opportunity of drawing attention to the Ostracoda lately found in the London Clay from an excavation in Piccadilly, London; and with them we group in this paper all the species known to occur in that formation, giving illustrations of these London Clay forms in one plate, so as to present their *facies* at a glance,—with the exception of two species which reached us after the plate was finished, but figures of which are given in the text. The order of description is arranged according to the natural grouping of genera adopted by Dr. G. S. Brady in his latest memoirs on recent Ostracoda.

Cypridea, Bosquet, 1852.

This genus is described at large in the Quart. Journ. Geol. Soc. vol. xli. (1885), p. 336. Remarks on the possible alliance existing between *Cypridea* and *Chlamydotheca* have been made by G. S.

[1] See the "Monogr. Post-Tert. Entom." by Brady, Crosskey, and Robertson, Palæont. Soc. 1874.

Brady, in the 'Proceed. Zool. Soc. Lond.,' 1886, p. 90; and in the 'Journ. Linn. Soc.,' vol. xix. (1886), pp. 200, 201.

1. Cypridea spinigera (Sow.).

This is referred to at pp. 316, 333, 334, Quart. Journ. Geol. Soc. vol. xli. as a species common in the upper part of the Weald Clay; and we now find that it occurs in Tertiary beds at Hempstead in the Isle of Wight. Specimens, young or imperfect, from this locality were figured in the "Geological Survey Memoir on the Isle of Wight," 1856, as a sub-reniform Ostracod with a sharp spine on each valve, *Cytherideis unicornis* (Jones). Careful examination of a further series of specimens leaves no doubt that it is the same species as that found in the Wealden beds. The Hempstead specimens are not so well preserved as those in the Wealden Clays, nor are they so abundant; but, with the many individuals that have come under our notice, we have been able to match old and young perfect examples from the Tertiary and Wealden formations.

2. Cypris incongruens, Ramdohr.

Cypris setigera, Jones, Monogr. Tert. Entom., 1856, p. 12, pl. i. fig. 6.
Candona compressa (Koch), Geol. Mag. 1870, p. 155.

To the localities of Berkshire and Cambridgeshire mentioned in the Monograph, 1856, we have to add the Valley-drift of Fisherton at Salisbury (Dr. Blackmore's Collection), Portland raised beach (Prestwich), and lacustrian bed near Hitchin (W. Hill).

3. Potamocypris trigonalis (Jones); and var. lævis, nov.

We have two examples of this species from Mr. Clement Reid's Collection,—one from the Norwich Crag at Bramerton,—and one from the Weybourn Crag at East Runton.[1] The latter specimen, being larger and smooth, may be distinguished as var. lævis.

4. Aglaia? cypridoides, sp. nov.

The genus *Aglaia*, G. S. Brady (1868), one of the *Cyprididæ*, has here a fossil form provisionally referred to it on account of the similarity of shape and condition of the valves. The muscle-spot, however, is like that of *Bairdia*. Our example is from the Norwich Crag of Bramerton, and was collected by Mr. Clement Reid, F.G.S. It has the usual curved form, and is delicately pitted. It is too broad in shape for either *A.? glacialis*, G. S. Brady, "Post-Tert. Entom.,"

[1] Mr. Clement Reid, F.G.S., has given a detailed account of the Norfolk Deposits in the "Mem. Geol. Survey; The Geology of the Country around Cromer," 1882. The Weybourn Crag is described at pp. 11—19; and the Entomostraca from that deposit are mentioned at p. 66. See also Prof. Prestwich's Memoir on the Crag Beds of Suffolk and Norfolk; Quart. Journ. Geol. Soc. vol. xxvii. p. 457, 460, etc.; and H. B. Woodward's "Geology of England and Wales," 2nd edit. pp. 465-474, for Bramerton, Weybourn, etc. The Bramerton Crag is also treated of in H. B. Woodward's "Geol. Surv. Mem.; The Geology of the Country around Norwich," 1881, pp. 33-55, 82, etc. The list of Ostracoda from Weybourn referred to above does not agree with our determination in all respects. Thus we have not found *Cythere tuberculata*, Sars, nor *C. pellucida*, Baird, among the specimens we have seen; and probably *C. concinna*, Jones, is represented by the set of the closely allied *C. angulata*, Sars, which we have met with. Other species in our series are not indicated in the printed list referred to.

p. 132, pl. xi. figs. 54–56; or *A.? obtusata*, G. S. Brady, "Report Challenger Ostrac.," p. 35, pl. xxx. fig. 8.

5. Bythocypris subreniformis, sp. nov.

In the genus *Bythocypris*, determined by G. S. Brady, in "Report Challenger Ostrac.," 1880, the left valve is described as much larger than the right, and overlapping it above and below. In this character, and other features, a specimen from the "Belosepia-bed" at Bracklesham (Science Schools Coll.) coincides. It approaches *Cytherina abbreviata*, Reuss, "Haidinger's Nat. Abh.," vol. iii. p. 52, pl. viii. fig. 10; but it is too short and too high, and is not so reniform. It has the usual kidney-shape, and is also near *B. reniformis*, G. S. Brady, "Report Challenger Ostrac.," p. 46, pl. v. fig. 1; but this figured form is too short, and more incurved on the ventral edge than is our specimen.

6. Pontocypris (?), sp.

A single, small, pitted valve, of uncertain alliance, but approximately like some members of the genus *Pontocypris*, G. O. Sars, occurs in a collection from the Tertiary beds at Colwell Bay.

7. Bairdia subdeltoidea (Münster), Jahrbuch für Min. etc. 1830, p. 64; and 1835, p. 446.

(For synonyms see Monogr. Tert. Entom. p. 52.)

As mentioned in the Geological Magazine for 1870, p. 157, the little *Bairdia* from the Crag ('Monogr. Tert. Entom.,' 1856, p. 52, pl. iv. fig. 2) may be *B. fusca*, G. S. Brady, 'Trans. Zool. Soc.' vol. v. p. 364, pl. lvii. fig. 9; and the fine species from the London Clay ('Monogr.' p. 52, pl. vi. fig. 1) is probably *B. subtrigona*, Bornemann, 'Zeitschr. deutsch. geol. Ges.,' vol. vii. p. 357, pl. xx. fig. 4.

We have now from the Bracklesham Belosepia-bed (Science Schools Coll.), a very fine example of the real *subdeltoidea*, which we have compared with authentic specimens from Osnabrück, sent by Count Münster to London many years ago.

With the Bracklesham specimen is a smaller individual, relatively thicker and rounder; it may belong to a different species, but for the present we leave it as a variety.

8. *Bairdia subtrigona*, Bornemann. Pl. XI. Fig. 1.

B. subdeltoidea, Jones, Monogr. Tert. Entom., 1856, p. 52, pl. vi. fig. 1.

This specimen from the London Clay is re-figured from the above-mentioned Monograph. As mentioned in our description of *B. subdeltoidea*, we now refer this species to Bornemann's *B. subtrigona*.

9. Bairdia Londiniensis, sp. nov. Pl. XI. Fig. 2.

This is a small neat *Bairdia*, of a not unusual form, but not exactly matching in shape any species known to us; it is moreover denticulated at the end margins, and punctate all over with very distinct, roundish, close-set pits. This valve is stained with numerous bright orange-irony spots, which possibly may be traces of the original colouring of the shell.

From the London Clay, Piccadilly; collected by Messrs. Sherborn and Chapman.[1]

10. Bairdia rhomboidea, sp. nov.

A stiff-looking *Bairdia;* broadly angular in front; nearly parallel above and below; narrow behind, with a curve on the ventral, and a slope on the dorsal edge of this end. The antero-ventral margin is suddenly constricted, leaving a projection behind the antero-ventral slope. The surface is very delicately punctate.

From the White (*Coralline*) Crag of Sutton, Suffolk.

11. Bairdia ovoidea, sp. nov. Pl. XI. Fig. 3.

A very small roundish *Bairdia*, pitted, rosetted at the muscle-spot, of a rather unusual pattern. It is like fig. 2, pl. iv., Monog. Tert. Entom., but much less of a subdeltoidal shape, being well rounded before, and slopingly curved behind, with the greatest fullness in the front moiety; hence, though both ends are somewhat obliquely rounded, the anterior half of the valve is broader than the hinder portion.

From the London Clay, Piccadilly. Collected by Sherborn and Chapman.

Cythere, Müller, 1875.

Valves unequal (left valve usually somewhat larger than the other), oblong-ovate to quadrate in shape, smooth or rough, mostly highest in front; hinge with teeth and sockets at anterior and posterior angles, variously developed.

The quadrate and rough forms have been classed as *Cythereis* ('Monogr. Cretac. Entom.,' 1849, p. 14); and, although this group will not hold its own as a true genus, Dr. G. S. Brady having shown that the animals do not differ from other *Cytheræ*, yet it is a very convenient grouping for palæontologists, who have to study the valves only of these small fossil Crustacea.

12. Cythere recurata,[2] sp. nov.

Oblong-reniform, nearly equal at the ends in the outline, but thickest posteriorly, as seen in edge view. Approximating to fig. 7*g*, of G. S. Brady's *C. demissa*, in pl. xii. of the "Report Challenger Ostracoda," but more even in outline. Coarsely punctate; the pits somewhat in lines, but with a tendency to assume a concentric arrangement on the front half of the valve. Others are of the same outline, but differ in the ornament.

From the "Norwich Crag" of Southwold.

13. Cythere venustula, sp. nov.

Oblong, rounded at the ends, broadly oblique in front, semi-circular behind; straight on the ventral margin, oblique dorsally by the

[1] In the 'Journ. R. Micros. Soc.' ser. 2, vol. vi. p. 740, this specimen was doubtfully collated with Sowerby's *Cypris barbata* ('Trans. Geol. Soc.,' ser. 2, vol. v. 1834, p. 131, pl. ix. fig. 1), but this was probably a *Cythere*.

[2] "Finished in a workman-like manner."

swelling of the anterior hinge-joint. Depressed on the front half, but more convex behind. Surface ornamented with a neat open network of delicate meshes, lying obliquely from the postero-dorsal to the antero-ventral region.

From the Belosepia-bed at Bracklesham. (Science Schools Coll.)

14. Cythere Reidii, sp. nov.

Valves sub-oblong, obliquely rounded at the ends, broader in front than behind, straight on the back, slightly sinuous below, nearly flat; rising into a median knob in the anterior third. Surface with rather coarse punctation, making a rough reticulation. Named after Mr. Clement Reid, F.G.S., who collected this and many other undescribed Ostracoda from the Crag beds of Norfolk. From the Weybourn Crag of East Runton. (Museum of Practical Geology.)

15. Cythere retifastigiata, Jones.

Mr. Clement Reid has met with a good example, with less prominent ridges than in the figure in the 'Monograph,' 1856 (pl. iii. fig. 7), and with a smaller, neater, and closer punctation. Weybourn Crag. (Mus. Pract. Geol.)

16. Cythere lacrymalis, sp. nov.

One of the sub-oblong punctate *Cytheræ*, of a not uncommon shape, but rather more oblique anteriorly than usual. Surface slightly convex, swelling at the anterior third, and posteriorly bearing two separate, short ridges, which rise near the middle of the valve, and end each in a strong knob at the posterior border, thus forming two long tear-shaped eminences, instead of the more usual pair of posterior swellings, such as we see in *C. bidentata*, Bosquet, Tert. Entom., 1852, p. 72, pl. iii. f. 9, and several other Tertiary *Cytheræ*. From the Norwich Crag, Bramerton, collected by Clement Reid, F.G.S. (Mus. Pract. Geol.)

17. Cythere dictyosigma, Jones.

This was not figured in the 'Monogr. Tert. Entom.,' 1856, p. 33; but we hope to figure it shortly. We may remark that some of Dr. G. S. Brady's illustrations of his *Cythere mutabilis*, 'Trans. Zool. Soc.,' 1866, p. 377, pl. lix. fig. 14 (*C. tuberculata*, G. O. Sars, Brady, etc., Post-Tert. Entom., p. 164), approach very near to *C. dictyosigma*.

18. Cythere angulata (G. O. Sars), var.

Cythere angulata, G. S. Brady, Trans. Linn. Soc. vol. xxvi. p. 409, pl. 26, figs. 39-42.

In some of their more important characters our little specimens agree with Dr. G. S. Brady's definition of *C. angulata*; but in them we also see a strong affinity to *C. limicola*, Norman; *C. globulifera*, Brady, and *C. concinna*, Jones, as described in full by G. S. Brady, are also near allies.

Our specimens were obtained by Mr. C. Reid from the Norwich Crag of Bramerton, and the Weybourn Crag of East Runton; and are in the Mus. Pract. Geology.

19. Cythere Charlesworthiana, sp. nov.

A neat small *Cythere*, oblong, with front end rather obliquely rounded, and the posterior nearly square. Ventral edge slightly incurved, dorsal faintly arched. Broadest at the anterior third near the front hinge-joint. Surface ornamented with very delicate elongate pits, arranged in lines lengthwise, but curving in front, parallel with the margin. The anterior margin is neatly denticulate, especially on its dorsal third. This differs from our *Cythere recurata* in being truncated posteriorly and denticulated in front, and also in its ornament. The form nearest to this that we know of is *C. tenera*, G. S. Brady, Trans. Linn. Soc., vol. xxvi. p. 399, pl. 28, fig. 29–32; but in shape and ornament it differs.

From the Weybourn Crag of East Runton, collected by Mr. Clement Reid. (Mus. Pract. Geol.)

In memory of his early researches in the Crag, we name this species after Mr. E. Charlesworth.

20. Cythere villosa, Sars. B. C. and R., Monogr. Post-Tert. Entqm. 1874, p. 157, pl. iii. figs. 7-13.

Subtriangular, straight on the ventral, and obliquely arched on the dorsal and front edges, but somewhat truncate behind. Surface bearing a concentric reticulation of coarse angular pittings. Three tubercular swellings affect the valve just within its thickened rim, two behind, such as are frequent in this group of *Cytheræ*, and one in the antero-ventral third. The greatest convexity of the valves is central, making the edge-view acute-oval.

From the Weybourn Crag of East Runton. Collected by Mr. Clement Reid. (Mus. Pract. Geol.)

With this species we connect a variety from the "Norwich Crag" of Southwold, in which the tubercles are not so definitely marked. The places of the two near the ventral margin are occupied by irregular swellings, and the postero-dorsal tubercle is ill-defined.

21. Cythere læsa, sp. nov.

Ovate-oblong, straighter on the ventral than on the dorsal edge. Close to the ventral margin is a broad, longitudinal, somewhat sinuous ridge, widened, or rather doubled, with an oval interspace at its posterior third, and irregular at the anterior third. In one specimen the surface is coarsely reticulate with angular meshes; in the other, the ornament consists of a smaller mesh-work. In this latter individual the edge-view is less convex than in the other.

Norwich Crag, Bramerton. Collected by Mr. Clement Reid. (Mus. Pract. Geol.)

22. Cythere Woodwardiana, sp. nov.

Sub-trigonal; obliquely rounded in front, nearly semicircular behind; broad across the anterior third by the projection of the hinge-joint. Surface slightly convex; ventral surface somewhat flattened. Superficial ornament a coarse irregular pitting.

We name this species after Dr. Samuel Woodward, one of the earliest workers in these late Tertiary deposits.

From the Weybourn Crag, East Runton. Mr. C. Reid. (Mus. Pract. Geol.)

23. Cythere arenosa, Bosquet. Pl. XI. Fig. 4.

This is one of the papulated forms of *Cythere*, the surface having low, tubercular, and obscure meshes, which in other instances form strong tubercles. In some cases these become ragged warts (*C. scabra*, Münster; see Bosquet, Entom. Tert., p. 103, pl. v. fig. 7); in others they pass into spines (*C. ericea*, *C. irpex*, and others; G. S. Brady. "Challenger Ostrac.," pl. xvii. and xviii.); we have also a passage-form. The above and two following forms have a subovate edge-view. They were found in the London Clay of Piccadilly, London, by Messrs. Sherborn and Chapman.

24. Cythere scabropapulosa, Jones. Pl. XI. Fig. 5.

This specimen from the London Clay of Piccadilly is more uniformly convex and more rounded posteriorly than the Bracklesham specimen figured in the Monograph, 1856, pl. v. fig. 16. Moreover, the anterior margin is strongly denticulated, but the dorsal edge is not quite so roughly tuberculate as seen in the valve from Bracklesham.

Dr. G. S. Brady's "*C. scabropapulosa*" from the Antwerp Crag (Trans. Zool. Soc. vol. x. p. 393, pl. lxvi. fig. 2), being much rougher and more warty, is nearer to *C. scabra*, Münster, and might be regarded as *C. scabropapulosa*, var. *rudis*.

25. Cythere scabropapulosa, Jones, var. aculeata, nov. Pl. XI. Fig. 6.

This is a well-grown valve of *C. scabropapulosa* becoming hispid, by the tubercles ending with a sharp prickle or spine. A further development of this spinose condition is seen in *C. irpex*, Brady, as above mentioned. This also is from the London Clay of Piccadilly.

26. Cythere gyriplicata, sp. nov.

Narrow-suboval in outline, hinge-line slightly convex, but distinct. Ends rounded; narrow behind, somewhat oblique in front. Surface sculptured with delicate longitudinal ridges, arranged concentrically towards the margins, and united by smaller transverse ridges.

From the *Belosepia*-bed of Bracklesham. T. R. Jones' Collection.

The nearest species we know of is Bosquet's *C. multicostata*, Entom. Tert., p. 59, pl. ii. fig. 12; but this is very much coarser and broader, and without any sign of reticulation.

27. Cythere delirata,[1] sp. nov.

A *Cythere* of the not uncommon sub-oblong form, but with the rare ornament of slight furrows diverging up and down from the median line of the posterior region, and becoming more or less concentric or confused anteriorly. Edge view long-oval.

From the Fluvio-marine beds of Headon Hill, Isle of Wight. (Fred. Edwards' Collection in the British Museum.)

[1] Ploughed with divergent furrows.

EXPLANATION OF PLATE XI.

(Ostracoda from the London Clay.[1])

Fig.

1. *Bairdia subtrigona*, Bornemann.
2. „ *Londiniensis*, sp. nov.
3. „ *ovoidea*, sp. nov.
4. *Cythere arenosa*, Bosquet.
5. „ *scabropapulosa*.
6. „ „ var. *aculeata*, nov.
7. „ *scalaris*, sp. nov.
8. „ *scrobiculoplicata*, Jones.
9. *Cythereis Bowerbankiana*, Jones.
10. *a*, *b*. „ *aranea*, sp. nov. ; *b*, ventral aspect.
11. *a*, *b*. „ *Prestwichiana*, sp. nov. ; *b*, transverse section.
12. *Cytheridea perforata* (Roem.), var. *insignis*, Jones.
13. „ *glabra*, Jones.
14. *a*, *b*. *Krithe Londiniensis*, sp. nov.
15. *a*, *b*. „ *glacialis*, B. C. and R.
16. *Cytheropteron triangulare* (Reuss).
17. *Cytherella fabacea*, Bornemann.
18. „ *Beyrichi* (Reuss).
19. „ *compressa* (Münster).

(*To be continued.*)

II.—On some Belgian Fossil Reptiles.

By Louis Dollo, C.E.,
Assistant Naturalist in the Royal Museum of Natural History of Belgium, Brussels.

I HAVE read with much interest the two articles which Messrs. G. A. Boulenger and R. Lydekker have recently published in the Geological Magazine,[2] and I should be very much obliged if you would permit me to make an addition, which appears to me useful, and which I should be glad to see published.

I. Pseudotrionyx.[3]—1. I have remarked with satisfaction that it has been possible for the above-named naturalists to refer to *P. Delheidi*, a Tortoise of the London-clay. This discovery is doubly interesting, in the first place because it shows the existence of the Belgian fossil in England, in the second place, because it establishes the existence of the Bruxellian (Middle Eocene) Chelonian in the Ypresian epoch (Lower Eocene).

2. I do not, however, believe that the absence of the horny scutes in *Pseudotrionyx* would be sufficient to create a new family.[4] In fact, I think, for reasons which I shall explain elsewhere,[5] that the *Thecophora*[6] without horny scutes (Gymnoderms) proceeded from types which possessed them (Lepidoderms). I believe also that

[1] See also woodcuts in the text.

[2] R. Lydekker and G. A. Boulenger, 'On Chelonia from the Purbeck, Wealden and London Clay,' Geol. Mag. June, 1887, p. 270. R. Lydekker, 'Notes on Hordwell and other Crocodilians,' Geol. Mag. July, 1887, p. 307.

[3] L. Dollo, 'Première Note sur les Chéloniens du Bruxellien (Eocène moyen) de la Belgique,' Bull. Mus. Roy. Hist. Nat. Belg. 1886, t. iv. p. 75.

[4] R. Lydekker and G. A. Boulenger, 'Chelonia,' etc. p. 274.

[5] L. Dollo, 'Première Note sur les Chéloniens oligocènes et néogènes de la Belgique,' Bull. Mus. Roy. Hist. Nat. Belg. 1887, t. v. (*in the press*).

[6] L. Dollo, 'Chéloniens du Bruxèllien,' etc., p. 79.

the disappearance of the scutes has taken place by a progressive diminution of their rigidity, a diminution in consequence of which the skin has been gradually moulded upon the subjacent bone, taking exactly its reliefs and hollows. At this stage it must have already possessed a vermiculated external surface of the carapace (as happens with the *Thecophora*, which have a soft skin, *Trionyx* for example), but the dorsal tegument was always divided into distinct areas, leaving their trace upon the above-mentioned external face. Such is perhaps *Anostira*,[1] and probably *Chelonia Suyckerbuyki*. Afterwards, these different areas have disappeared, and with them their lines of demarcation on the skeleton: take *Trionyx* and *Pseudotrionyx* as examples. We may then find, by future researches, all the passages between the gymnoderm and lepidoderm *Thecophora*, and I do not understand, consequently, how the presence or the absence of horny scutes could suffice alone to characterize a family.

II. Pachyrhynchus.[2]—1. As Messrs. Boulenger and Lydekker have pointed out,[3] this name has already been employed; it will therefore be necessary to change it. In a paper at present in the press[4] I have proposed to substitute for it *Erquelinnesia*, to recall the locality in which the curious Chelonian has been discovered, and where it is so common.[5]

2. As Messrs. Boulenger and Lydekker admit,[6] and contrary to the statement of Mr. E. D. Cope,[7] my *Pachyrhynchinæ*[8] are quite distinct from the *Propleuridæ*[9] of the celebrated Professor of Philadelphia, since the latter have nine pairs of costal plates, whereas the Chelonian of Erquelinnes has only eight.

3. Mr. Cope, notwithstanding the assertion to the contrary of Messrs. Boulenger and Lydekker,[10] does not refer, at least in the paper mentioned by them,[11] any of the species of Sir R. Owen to *Puppigerus*.[12] Besides, as I have said in a former paper,[13] *Erquelinnesia* is, without any doubt, generically different from the American type, since the latter has the xiphiplastrons united by

[1] J. Leidy, 'Contributions to the extinct Vertebrate Fauna of the Western Territories,' Rep. U. S. Geol. Surv. Territories (F. V. Hayden), Washington, 1873, p. 174 and 175, pl. xvi. fig. 1 and 2. E. D. Cope, 'The Vertebrata of the Tertiary Formations of the West' (book i.), Rep. U. S. Geol. Surv. Territories (F. V. Hayden), Washington, 1883, p. 112. L. Dollo, 'Chéloniens du Bruxèllien,' etc. p. 95.

[2] L. Dollo, 'Première Note sur les Chéloniens landéniens (Eocène inférieur) de la Belgique,' Bull. Mus. Roy. Hist. Nat. Belg. 1886, t. iv. p. 129.

[3] R. Lydekker and G. A. Boulenger, 'Chelonia,' etc., p. 270.

[4] L. Dollo, 'Chéloniens oligocènes et néogènes,' etc. (*v. supra*).

[5] L. Dollo, 'Chéloniens landéniens,' etc., p. 129.

[6] R. Lydekker and G. A. Boulenger, 'Chelonia,' etc., p. 271.

[7] E. D. Cope, 'Dollo on Extinct Tortoises,' American Naturalist, November, 1886, p. 968.

[8] L. Dollo, Chéloniens landéniens,' etc., p. 139.

[9] E. D. Cope, 'Tertiary Vertebrata,' etc., p. 111.

[10] R. Lydekker and G. A. Boulenger, 'Chelonia,' etc., p. 271.

[11] E. D. Cope, 'Dollo on Extinct Tortoises' (*v. supra*).

[12] E. D. Cope, 'Tertiary Vertebrata,' etc., p. 112.

[13] L. Dollo, 'Chéloniens landéniens,' etc., p. 131.

sutures. The Turtle of the New World, which the Belgian reptile resembles most, appears to me, as well as to Mr. Cope, to be *Euclastes*.[1] But I shall return to this subject on another occasion.

III. Peltochelys.[2]—Whatever may be the position of this form in classification, I do not believe that it can be identified with *Tretosternum*, as Messrs. Boulenger and Lydekker think.[3] In fact, with regard to *Tretosternum*, according to the naturalists just named, "the plastron is essentially of the *Dactylosternine* type of Cope."[4] Now I can assert that I have not seen the least trace of "more or less open digitations"[5] in the plastron of *Peltochelys*.

IV. Bernissartia.[6]—According to Mr. Lydekker,[7] with whom Mr. Boulenger agrees,[8] *Bernissartia* = *Hylæochampsa*,[9] for there would exist in the latter an orbito-latero-temporal notch.

1. In the first place, I beg leave to point out to these naturalists that Sir Richard Owen says plainly: "The orbits in *Hylæochampsa* are circular and better defined by the postfrontal from the lateral outlets of the temporal fossæ than in *Crocodilus*, and herein they more resemble the orbits in *Teleosaurus*,"[10] which agrees with the figure given by the celebrated palæontologist.[11] And, on the other hand, I can assert that, in *Bernissartia*, the orbito-latero-temporal notch is as clearly marked as in any living Crocodilian. The difference which I have pointed out is therefore quite real, although perhaps less strongly marked than I have stated.

2. In the second place, I will add that a naturalist peculiarly competent in the question under consideration, and who has also seen the type of *Hylæochampsa*, Mr. A. S. Woodward, is inclined[12] to consider it rather as a Teleosaurian, which supports what I have just said, and removes the English Crocodilian from *Bernissartia*.

3. However this may be, and until I shall have described in a more complete manner (and with numerous figures) the Crocodilians of Bernissart, I may add, to the character which I have already indicated, the following differences between *Bernissartia* and *Hylæochampsa*.

[1] E. D. Cope, 'Synopsis of the Extinct Batrachia, Reptilia and Aves of North America,' Trans. Amer. Philos. Soc. Philadelphia, 1871, p. 147 and pl. vi.

[2] L. Dollo, 'Première Note sur les Chéloniens de Bernissart,' Bull. Mus. Roy. Hist. Nat. Belg. 1884, t. iii. p. 76.

[3] R. Lydekker and G. A. Boulenger, 'Chelonia,' etc., p. 273.

[4] R. Lydekker and G. A. Boulenger, 'Chelonia,' etc., p. 273.

[5] E. D. Cope, 'Tertiary Vertebrata,' etc., p. 111.

[6] L. Dollo, 'Première Note sur les Crocodiliens de Bernissart,' Bull. Mus. Roy. Hist. Nat. Belg. 1883, t. ii. p. 309.

[7] R. Lydekker, 'Crocodilians,' etc., p. 310.

[8] R. Lydekker, 'Crocodilians,' etc., p. 310.

[9] R. Owen, 'Monograph on the Fossil Reptilia of the Wealden and Purbeck Formations,' Supplement, No. VI. Crocodilia (Hylæochampsa), Wealden, Palæontographical Society, London, 1873.

[10] R. Owen, 'Hylæochampsa,' etc., p. 3.

[11] R. Owen, 'Hylæochampsa,' etc., pl. ii., fig. 24.

[12] A. S. Woodward, 'On British Fossil Crocodilia,' Geol. Mag. Nov. 1887, p. 504. A. S. Woodward, 'The History of Fossil Crocodiles,' Proc. Geol. Assoc. Feb. 1886, p. 318.

Characters.	Hylæochampsa.[1]	Bernissartia.
1. *Ornamentation of the cranium.*	"The outer surface of the cranial bones shows a different pattern of sculpture from that in *Goniopholis*; instead of small circular pits, there are short irregular ridges, which, at some parts, the post-frontal, for example, have a tendency to diverge from a reticulate centre; a number of short ridges and clefts radiate from the raised part of the border of the temporal outlet; but all these accentuations of the surface are rather feeble" (pp. 1 and 2).	Ornamentation very accentuated and consisting in small circular pits.
2. *Orbits.*	A. "Circular" (p. 3). B. Antero-posterior diameter shorter than the corresponding one of the supratemporal fossæ; transverse diameter longer than the corresponding one of the supratemporal fossæ. C. Orbits neither horizontal, nor vertical, but intermediate between the two.	A. No; having the form of the figure 8 of which the anterior circle has a much smaller diameter than the posterior one, but being equally well accentuated. B. Antero-posterior and transverse diameters much greater than the corresponding ones of the supratemporal fossæ. C. Orbits horizontal.
3. *Interorbital space.*	Forming very distinctly, in its narrowest part, more than the half of the transverse diameter of an orbit.	Forming, in its narrowest part, very distinctly less than the half of the transverse diameter of an orbit.
4. *Supratemporal fossæ.*	Form very elongated, "teleosauroid" (p. 3).	Form more rounded.
5. *Intersupratemporal space.*	At the narrowest part, at least a third inferior to the transverse maximum diameter of a supratemporal fossa.	Perceptibly equal, in its narrowest part, to the transverse maximum diameter of a supratemporal fossa.
6. *Posterior border of the superior surface of the cranium seen from above.*	With three notches of which one is median.	With two symmetrical notches and a point on the median line.
7. *Pterygo-palatine vacuities.*	Slight, very narrow and elongate.	Enormous and much broader in proportion to their length.
8. *Interpterygo-palatine septum.*	Much thicker, at its narrowest part, than the transverse diameter of one of the pterygo-palatine vacuities.	Much thinner, at its narrowest part, than the transverse diameter of one of the pterygo-palatine vacuities.
9. *Choanes.*	A. Rounded. B. Situated very distinctly nearer the occipital condyle.	A. Elongated in the direction of the longitudinal axis of the cranium. B. Placed very perceptibly more anteriorly.
10. *Size.*	At least $\frac{3}{4}$, if not $\frac{1}{2}$, greater than that of our greatest specimen of *Bernissartia*.	The entire cranium of our largest specimen of *Bernissartia* is not greater than the preserved portion of that of *Hylæochampsa*.

[1] The figures between brackets, in this column, indicate the pages of the Monograph of Sir R. Owen.

To conclude, from the preceding remarks, I think that *Bernissartia* cannot be considered as a synonym of *Hylæochampsa*, and, that consequently, the name of the Crocodilian of Bernissart ought to be retained, instead of placing it in a list of synonyms.

III.—On *Ammonites serpentinus*, Reinecke, *Am. falcifer*, Sowb., *Am. elegans*, Sowb., *Am. elegans*, Young, etc.

By S. S. Buckman, F.G.S.

I HAVE had occasion lately to thoroughly investigate these and other allied Ammonites, partly because it has been important to me that I should know the true affinities of these species, partly because my attention was directed to certain still obscure points with regard to their identification, and partly on account of the statement by the late Dr. Wright that *Am. serpentinus* and *Am. falcifer* were the same species. In pursuing my investigations I have received a great deal of assistance from Dr. E. Haug's Beiträge zu einer Monographie der Ammoniten-gattung Harpoceras,[1] which I am pleased to acknowledge, although I do not find myself able to agree with him in one or two small points which I will presently mention. Meanwhile, by the aid of a few references to well-known works, I will indicate the Ammonites so that they may be understood.

Hildoceras ? serpentinum (Reinecke).

1818. *Argonauta serpentinus*, Reinecke, Maris protog., p. 89, fig. 74–75.
? 1822. *Ammonites Strangewaysi*, Sowerby, Min. Conch. t. 254, fig. 1 and 3.
Non *Am. serpentinus*, D'Orb. (figure reduced), Wright, Bayle, etc.

This Ammonite seems to be extremely scarce. What has been called by D'Orbigny, Wright, and others, *Am. serpentinus*, and is so labelled in museums and private collections, is the *Ammonites falcifer* of Sowerby, which has been erroneously supposed to be the young state of *Am. serpentinus* (Reinecke). Oppel, in his Juraformation, p. 243, noticed that this was not so, and keeps both species distinct; and Dr. E. Haug, in his Beiträge Monog. draws pointed attention to the fact of *falcifer* having been generally figured for *serpentinus*. Dr. Haug corrects this error, and separates the *Am. serpentinus* totally from *Am. falcifer*, placing *Am. serpentinus* in the group of *Am. bifrons*, and consequently in Hyatt's genus *Hildoceras*. The form of the inner margin, the general outline of the ribs, obscure, it would seem, on the inner part of the whorl, seem to warrant this; but at the same time it lacks the furrows on each side of the keel present in *Hild. bifrons*. Of its suture-line I can say nothing, but the suture-line of *Hild. bifrons* is very distinctive. To whatever genus the true *Am. serpentinus* belongs, I feel convinced it does not belong to the same genus as *Am. falcifer*; and that *Am. falcifer* does not belong to the genus *Hildoceras* is very clear, on account of the suture-line, the shape of the inner margin, etc., but especially on a distinctive structural difference in the keel. The keel of *Hildoceras bifrons* is filled by the mould, and is the same shape in reference to the ventral

[1] Neues Jahrbuch für Mineral. Beil. Bd. iii. 1885.

area when the test is present or absent; but the keel of *Am. falcifer* is separated from the mould by an inner layer of shell; and the two sides of the keel and this layer form a triangle inclosing a hollow space, which has become filled with mud. Where, therefore, the test is absent, the mould of *Am. falcifer* becomes rounded on the ventral area. This kind of keel is well shown by Dr. Haug, Beiträge Monogr. Harpoceras, plate xi. fig. 1, for *Am. variabilis*; and it is to be seen in the genera *Hammatoceras*, *Sonninia*, etc.; but this structure of the keel is not shown in the genera *Hildoceras*, *Ludwigia*, *Lioceras*, etc. It therefore seems right to separate *Am. falcifer* generically, and since Dr. Haug has proposed to restrict Waagen's genus *Harpoceras* to a small group of which *Am. falcifer* is the type, we desire to follow such a good suggestion.

Genus Harpoceras, Waagen, emend. Haug.

Ribs sickle-shaped, much produced on ventral area. Keel distinct and hollow, separable from the mould; ventral area of mould rounded when keel absent, no furrows on either sides of the keel, inner margin square; large accessory lobe in siphonal saddle; large and much branched superior lateral lobe; inferior lateral and auxiliaries retracted.[1]

Harpoceras falciferum (Sowerby).

1822. *Ammonites falcifer*, Sowerby, Min. Conch. t. 254, fig. 2.
1846. ——— *serpentinus*, D'Orbigny (non Reinecke), Pal. fr. t. 55.
1878. *Lioceras serpentinum*, Bayle, Explic. carte géol. iv. t. 87, figs. 2-3.
1882. *Harpoceras serpentinum*, Wright, Lias Am. t. 58.

The above list of references will at once show how this Ammonite has been misunderstood. D'Orbigny, Wright, and other authors have extinguished Sowerby's names of *Strangewaysi* and *falcifer*, considering them to be the same and also equivalent to Reinecke's *serpentinus*. In this they were perhaps right as far as *Am. Strangewaysi* is concerned, which is very near to Reinecke's *Am. serpentinus*; but Sowerby was certainly correct when, having the two specimens in front of him, and putting them for comparison on the same plate, he made them two different species; and it is singular that D'Orbigny, Wright, etc., should have figured as Reinecke's *serpentinus* what is really *Am. falcifer*, for a comparison of the inner edges of the whorls should have shown this to be a mistake. Sowerby distinctly says of *Am. Strangewaysi*, "inner edges of the whorls obliquely flattened," and of *Am. falcifer* that it differs from *Am. Strangewaysi* by "wanting the flat surface of the inner margin of the whorl," and Reinecke distinctly shows the section of his *serpentinus* (fig. 75) with the inner margin obliquely flattened. Again, the coiling is very different. In Reinecke's *serpentinus* it is regular throughout; in Wright's figure it is irregular, that is, the inclusion becomes less with every whorl. Reinecke's *serpentinus*, which is

[1] Compare genus *Hildoceras*. Mould showing shape of keel; ventral area flattened or furrowed; inner margin subconcave, sloping. Very broad siphonal saddle, small accessory lobe, superior lateral lobe little branched, inferior lateral and auxiliaries produced.

3 inches 4 lines in diameter, has four whorls at least. Wright's *serpentinus* at the same diameter has barely three. Taking the diameter of Reinecke's figure as = 100, the breadth of the outer whorl is 29·6, whilst taking the same diameter on Wright's figure (3 inches 4 lines), we find the breadth of the outer whorl at that size is 40·7. I think it is therefore clear that Sowerby's *Am. falcifer* is not Reinecke's *Am. serpentinus*.

Harpoceras elegans (Sowerby).

1815. *Ammonites elegans*, Sowerby, Mineral Conch. vol. i. table 94, upper figure.
1884. *Harpoceras bicarinatum*, Wright (non Zieten), Lias Ammonites, Pal. Soc. 1884, plate 82, figs. 9 and 10 (non 11).
Non *Am. elegans*, Young and Bird, non *Harpoceras elegans*, Wright.

Sowerby describes his species in the following terms:—

"*Spec. Char.* Involute, much depressed, acutely keeled; volutions about three, inner ones about two-thirds concealed; radii twice curved, numerous, equal; keel distinct, entire; aperture acutely triangular; internal angles truncate.

"A delicate species with a thin shell; thickness about one-sixth of the largest diameter; it gradually lessens towards the edge, which is rather obtuse, with a sharp keel placed upon it. The septa are tolerably close with their sinuous margins much plaited: the siphuncle slender within the keel."

Sowerby's type-specimen is not in the British Museum collection, and so unfortunately we cannot refer to it; but although the species has been much misunderstood, I think that if the figure and the description be accurately studied, we shall be able to arrive at definite conclusions about it. One thing is perfectly certain, that the *Am. elegans* of Young and Bird is not Sowerby's *elegans*. Dr. Wright has figured on plate 63, *Harpoceras elegans, Sowerby*, but has corrected this in his text, page 447, to *Young*, and he further states: "Some authors refer this species to *Am. elegans*, Sowerby, but none of the specimens I have examined correspond with Sowerby's figure, which does not appear to be a Lias shell at all." However, on p. 462 he places *Am. elegans* of Sowerby as a synonym of *Harp. bicarinatum*, and in this matter I think he was so far correct that I think his *Harp. bicarinatum*, plate 82, figs. 9, 10, are really Sowerby's *Am. elegans*, and certainly not *Am. bicarinatus* of Zieten, plate 15, fig. 9, which has a far smaller centre.

Dr. Haug, on page 680 of his Beiträge Monog. Harpoceras, is mistaken in supposing Dr. Wright to have figured Sowerby's *Am. elegans* on plate 63, and Dr. Wright himself corrects this. Sowerby's *Am. elegans* does not belong to the group of *Am. opalinus* as Dr. Haug has placed it, though undoubtedly *Am. elegans*, Wright, does. Therefore we have this position:—The *Am. elegans*, Sowerby, I consider to have been figured again by Wright as *Am. bicarinatus*, and not to be Zieten's *Am. bicarinatus*, and that it is also a distinct species in itself. Further, that it belongs to the restricted group of *Am. falcifer*, which is now erected into a genus, and therefore must be called *Harpoceras elegans*, Sowerby. On the other hand, the

name of *Am. elegans*, Young, ought in reality to be cancelled; but we know from Young that it has a concave inner margin, and Wright has given a very good figure of a shell of this kind, which agrees with Young's description, and as this shell of Wright's would belong to a different genus, and possesses no other name, perhaps it is as well to retain this one. Also, since it belongs to the genus *Lioceras*, it would be correctly stated as *Lioceras elegans* (Young, or Wright), and would be well distinguished from *Harpoceras elegans* (Sowerby).

There is one point about this latter species, namely, that Sowerby states that the siphuncle is within the keel. As *Harpoceras* in its restricted definition is distinctly not so, we think he may have mistaken the hollowness for the siphuncle, as he did in his figure of *Am. Sowerbyi*, pl. 213.

HARPOCERAS EXARATUM, Wright.

1822. *Ammonites exaratus*, Young and Bird, Geol. Surv. Yorks. p. 266.
1882. *Harpoceras exaratum*, Wright, Lias Am. Pal. Soc. pl. 62, fig. 1.

As Young does not give any figure of his species, we cannot say what it may be, and therefore accept Wright's figure as the type of the species. It seems, judging from the figure, to belong to the genus *Harpoceras*. It is certainly not, as Wright has mentioned in his synonyms, *Am. complanatus* of D'Orbigny, which has a very different sectional view and smaller centre. This species has the same sized umbilicus as *Harp. elegans* (Sow.), but differs in the sectional view, the sides being less sloped towards the ventral area. If there are no other differences, I should be inclined to regard this shell as merely a variety of Sowerby's *H. elegans*.

HARPOCERAS SUBPLANATUM (Oppel).

1844. *Ammonites complanatus*, D'Orb., Terr. Jur. p. 353, pl. 114, figs. 1–2.
1856. ——— *subplanatus*, Oppel, Juraf. p. 244.

Dr. Wright has given *Am. complanatus*, D'Orb., as a synonym of *Harp. exaratum*; but I think that a comparison of the centres and the section of D'Orbigny's and Wright's figures will show this to be a mistake, and Dr. Haug (p. 619) has wisely separated the two species. Dr. Haug has included both of these species in the group of *Am. falcifer*, and also *Am. discoides*; but I am inclined to think that *Am. discoides* should be separated. It has a likeness in regard to its ribbing, but it has in reality no keel, only the ventral area sharpened, and, judging from the suture-line, I consider that it does not belong to *Harpoceras* at all, but should be classed in proximity with *Oppelia*. *Harp. subplanatum* occurs in England; by the kindness of Mr. B. Thompson, F.G.S., I have been able to examine a specimen from Northamptonshire.

We have, therefore, in the genus *Harpoceras*, *Harp. falciferum*, Sow., *Harp. elegans*, Sow., *Harp. exaratum* (Young), Wright, and *Harp. subplanatum*, Oppel; whilst *Am. serpentinus*, Reinecke, perhaps belongs to the genus *Hildoceras*, and as the species was not

figured by Wright in his Monograph, a good figure of it in its various stages would be an advantage.[1]

Besides these species, we have *Am. elegans*, Young, which belongs to the genus *Lioceras*, and we have *Am. bicarinatus*, Zieten, which is distinct from any we have mentioned on account of its smaller centre and furrows on the ventral area, and in all probability belongs to another genus. I do not know if it has really occurred in England.

It may be interesting to notice the sizes of umbilicus in these various species taken from the figures given. The diameter = 100, the umbilicus of *Harp. falciferum* is, youth (Sowerby) 31·9; adult (Wright) 40·5, showing the decrease of inclusion I have mentioned. *Harp. exaratum* (Wright's figure) 20·5 and *Harp. elegans* (Sow. figure) 20·7. (These two have a different sectional view.) *Harp. subplanatum* (D'Orb. pl. 114) 16·76, *Am. bicarinatus* (Zieten's figure) 12·2. Whilst Wright's *Am. bicarinatus*, pl. 82. fig. 9, which I contend is Sowerby's *Am. elegans*, has, umbilicus 19·00, which is almost exactly the same as Sowerby's figure at the *same* diameter. I have given these measures exactly from the figures. Of course in ordinary work care would have to be taken as to the amount of body-chamber present, and the size of the specimen; but if allowance is made in the present instance for these, it will not account for the variation in the umbilicus in these species.

P.S.—If Sowerby's *Am. Strangewaysi* be really Reinecke's *Am. serpentinus*, I should much doubt, from the indications of suture-lines given by Sowerby, if it be correct to class it in the genus *Hildoceras*. Etymologically, as Dr. Haug wrote to me when making his suggestion, *Harpoceras* is very aptly applied to the true *Falciferi*. It is an important matter to assign a correct place to Waagen's genus which had been partly forestalled by Hyatt's genera *Tropidoceras*, *Hildoceras*, *Lioceras*, *Grammoceras*, *Hammatoceras*, and to another section of which Bayle gave the name *Ludwigia*. In accordance with these genera the restriction of *Harpoceras* becomes a necessity.

IV.—On Explosive Slickensides.

By Aubrey Strahan, M.A., F.G.S.

(Communicated by permission of the Director-General of the Geological Survey.)

DURING a recent examination of the lead-mines of Derbyshire, I was interested in some accounts of explosions which had taken place, which were not due either to any material used by the workmen or to fire-damp. Though at first inclined to believe that the accounts were exaggerated, I soon found that not only was the evidence of such explosions having constituted a real danger to the men overwhelming, but that accidents are still liable to occur from this cause. The explosions are connected with the structure known as slickenside in the veins. The vein-stuff, consisting generally of galena, calc-spar, heavy spar (sulphate of baryta), and fluor-spar, is divided by the planes of slickenside into more or less vertical sheets

[1] Wherever Dr. Wright has mentioned the zone of *Harp. serpentinum*, it must probably be taken to indicate the zone of *Am. falcifer*.

or slabs. Such sheets, when bared in the mining operations, fly to fragments with explosive violence on being struck, or even scratched by a miner's pick. The following extracts from old authors, and from communications on the subject that I have received, will serve to illustrate the nature of the explosions and the manner in which the danger was met by the men. The accounts relate chiefly to the mines near Eyam, but explosions occurred also in the Odin Mine near Castleton.

The earliest reference to the subject which I have met with is by Dr. Short :—

"On the North Side of this Mountain [Hucklow Edge, near Eyam] . . . is a Mine which cannot be wrought; for in picking or striking the Ore, the sudden shaking of the Metal gives such a violent Motion to the Sulphur, that it makes an Explosion like fired Gunpowder, or a Blast in a Rock, so as great Lumps rise up and fly about along with a Kind of *Terræ Motus*, or Earthquake." [1]

Pilkington,[2] writing fifty years later, remarks that "the crackling and explosions caused by scraping these slickensides with a pick-axe are well known, but hitherto not satisfactorily accounted for. They are said to lose the above property very soon after they are taken out of the mine. In regard to their external appearance, their smooth side greatly resembles black lead very thinly spread over the surface of any smooth body. But the rough side looks very much like to common limestone."

But the most detailed account is furnished by John Whitehurst,[3] and is, I think, of sufficient interest to be reproduced here in full :—

"I purpose giving some account of an extraordinary phenomenon which has frequently happened in Haycliff and Ladywash Mines at Eyam, and in Oden Mine at Castleton : the former are thus circumstanced.

"1. The minerals are contained in the fissures of the limestone, covered by a *stratum* of shale and grit, which retain their full thickness of sixty fathoms each.

"2. The minerals contained in the above mines are blended together so as to produce the appearance of white Italian marble clouded with black, and are so extremely hard and compact as to require blasting with gunpowder, to separate them from the general mass.

"3. Those in the Ladywash veins are divided in two equal parts parallel to the sides of the fissure. They may be compared to two slabs of marble, whose polished surfaces are absolutely in contact with each other without the least degree of cohesion.

"4. These naturally polished surfaces are not truly flat, but in some degree waved, as if formed by a carpenter's plane, consisting of various members.

"5. The two surfaces are generally coloured with lead ore, thinly

[1] The History of the Mineral Waters of Derbyshire, Lincolnshire, and Yorkshire, by Thomas Short, M.D., 4to., London, 1734, p. 96.

[2] A View of the Present State of Derbyshire, 1789, vol. i. p. 195.

[3] An Inquiry into the Original State and Formation of the Earth, by John Whitehurst, 3rd edition, 1792, London, p. 218, *et seq.*, plate i.

laid on, as if only rubbed over with black lead, though sometimes thicker.

"6. The vein in Haycliff Mine contains two of the above seams, and therefore may be compared to three slabs of marble, the middle one polished on both sides and in contact with the other two.

"Thus are the above veins circumstanced. Now what is yet more remarkable is this: if a sharp pointed pick is drawn down the vein with a small degree of force, the minerals begin to crackle, as sulphur excited to become electrical by rubbing; after this in the space of two or three minutes, the solid mass of the minerals explodes with much violence, and the fragments fly out, as if blasted with gunpowder. These effects have frequently happened, by which many workmen have been wounded, but none killed, both in the Eyam Mines, and in that called Oden, at Castleton.

"In the year 1738 a prodigious explosion happened in the mine called Haycliff. The quantity of two hundred barrels of the above minerals were blown out at one blast; each barrel, I presume, contained no less than three or four hundredweight. At the same time a man was blown twelve fathoms perpendicular, and lodged upon a floor, or bunding, as the miners call it, in one of the shafts.

"When the above explosion happened, the barrel, or tub, in which the minerals, etc., are raised to the surface, happened to hang over the engine shaft, which is nearly seven feet in diameter, and 448 yards distant from the forefield, or part, where the explosion happened; this barrel, though of considerable weight, was lifted up in the hook on which it was suspended; and the people on the surface felt the ground shake, as by an earthquake.

"Such are the effects which have frequently been produced in all the above mines; but from what cause they proceed, I have not yet been able to discover, nor even the least traces towards it. The substance having been analized, is found to consist of fluor and the ore of lead, but the cause of explosion still remains equally mysterious, though some attempts have been made to obtain a knowledge of this curious phenomenon.

"These curious observations I received from Mr. Mettam, of Eyam, overseer of the mines, who also addressed the following account of them to Mr. George Tissington, of Winster, principal agent of the works.

"Eyam, 2 July, 1768. Sir,—I send you by the bearer, two specimens of our *slickensides*, containing all the variety of minerals where the explosions happen; they fly out in such *slappits*,[1] smooth on one side. The explosions are sometimes heard to the surface, and felt like an earthquake; they frequently blow out all the candles in the mine, and split the *stemples*[2] into splinters as small as the twigs of a birch besom, to the distance of thirty or forty yards from the *forefield*;[3] others are broke, and some of them become too short

[1] *Slappits*, fragments of the minerals burst out of the vein.

[2] *Stemples*, joists laid across fissures, when the minerals are cut out, by way of making a floor, on which rubbish is deposited, to save the expense of raising it to the surface.

[3] *Forefield*, that part of the vein under workmanship.

and drop out. The smooth sides lie face to face, and have the appearance of being shot with a plane, consisting of various members. There is generally two of these divisions in our forefield at Haycliff, about eight or ten inches asunder, and a seam of white *kebble*[1] in the middle of that space, half an inch thick, in which the miners rake down a sharp pointed pick until the crackling ceases; then they run away, knowing that the explosion will follow in a minute or two. Sometimes a noise is heard like the beating of a church clock, after which the greatest explosions happen.—I am, yours, etc., William Mettam.—To Mr. George Tissington, Winster."

John Mawe also writes in 1802 that in the Odin Mine "is found that singular variety of lead ore, called *slickenside*. This galena presents a smooth surface, as if plated. Sometimes it forms the sides of cavities, and on being pierced with the miner's tool, rends with violence, and explodes with a crackling noise. The cause of this phenomenon has not been fully explained. I have seen a man, when he came out of the mine, only a few minutes after the explosion, who, regardless of the danger, had pierced the sides of this substance, and was much hurt, and cut violently, as if stabbed about the neck and other places with a chisel, whence he was unable to return to the mines for two weeks."[2]

"Sometimes the vein-stuff is found perfectly divided vertically, throughout, and the surfaces polished; and these are called *Slickensides* or Cracking-whole, which usually are ribbed or slightly fluted, horizontally: the appearances are very similar to those of faults, but extraneous matters do not usually accompany them, the sides being mostly in very close contact; and often, after one side is removed, so as to give room, especially if the surface be pecked or broken, large Slapits, Spels, or fragments fly off, sometimes with loud explosions, and continue so to do for some days or longer, until the gate or passage in such vein is greatly enlarged thereby: this is the case in Gang Mine, in Cromford, where the hard 1st Toadstone also, in the gates and shafts, thus spels off, until they want timbering often, to support the roof and sides. I could not learn, that the Slickensides in the Mines about Eyam explode now, on mere scratching, as they were said to do in the late Mr. Whitehurst's time."[3]

"In Gang Mine, where a *Slickenside* runs through the Vein, the Miner avails himself of a curious property attending such Veins, by drawing laces, stoops, or nicks, at about six inches apart and four inches deep, with the point of his Pick, from top to bottom of his face of work, when he then leaves for several hours, and on his return, finds all the Vein-stuff so furrowed, spelled, or slappeted off, and laying on the sole ready got to his hands."[4]

"When their edges occur in the face of the vein, on the miner striking his pick into the vein they separate, in some districts without,

[1] *Kebble*, a white opaque spar, calcareous, but not apt to break into rhomboidal forms.

[2] The Mineralogy of Derbyshire, by John Mawe, 8vo. London, 1802, p. 48.

[3] General View of the Agriculture and Minerals of Derbyshire, by John Farey, 8vo. London, 1811, vol. i. p. 250.

[4] *Ib.* p. 367.

in others with a slight report; and in some of the mines in the neighbourhood of Eyam, in Derbyshire, with *loud* reports, particularly in Cracking-hole vein, in Haycliffe title . . . . where in the centre of the vein, termed a shack vein, was a small white impalpable (not effervescing) powder, called a mallion, a quarter of an inch thick, which on being scratched, a loud explosion immediately ensued, before which explosion a singing kind of noise was heard. By setting a blast in the vein at a short distance from the mallion, after the blast was fired, in a few minutes an explosion took place, when a large quantity of the vein fell down. In the year 1790, a loud explosion took place from a slide joint of Slickensides going across, but not into the cheeks of the vein containing the mallion, which caused on its being stirred the loudest explosion and the largest quantity of vein materials to come down. . . . . The last great explosion was in the year 1805. It has sometimes happened that persons have been maimed or even killed by this phenomenon; which, however, has not been noticed from Slickensides *where no shale is incumbent.*" [1]

In writing of the mines on Hucklow Edge, William Wood refers to the Hay Cliff, as "a mine distinguished for having contained in great abundance, that extraordinary phenomenon in the mineral world, provincially called Slickensides. . . . The effects of this mineral are terrific: a blow with a hammer, a stroke or scratch with a miner's pick is sufficient to blast asunder the massive rocks to which it is found attached. . . . A person named Higginbotham once narrowly escaped with life, by incautiously striking this substance in the above mine. Experienced miners can, however, work where it greatly abounds without much danger. It is also known by the name of Cracking-whole." [2]

The phenomenon is referred to by W. Adam also, who supposes that the slickenside has been produced by the rubbing of the rocks against one another. "The intense heat generated by the motion of such vast masses (expanding the air in its pores) may account for its exploding when broken into, similar to lumps of glass when suddenly cooled, which explode on being scratched or slightly broken." [3]

"To avoid the danger attendant on working in its immediate contiguity, the miners use the precaution of merely making a small incision or aperture, with the point of the pick, and then retire to a place of safety, awaiting the result. In case of an explosion, it generally takes place in ten or fifteen minutes, and by the force attendant on which, considerable masses of ore, and even stuff, are detached." [4]

Sir Charles Lyell, referring to this subject in the 6th edition of

[1] An Account of the Explosion of Slickensides, by W. Watson, Edin. Journ. Sci. new ser. vol. ii. p. 186, 1829.

[2] The History and Antiquities of Eyam; with a minute account of the Great Plague, which desolated that village in the year 1666, by William Wood, 8vo., London and Derby, 2nd ed. 1852; 3rd ed. date not stated.

[3] The Gem of the Peak; or, Matlock Bath and its Vicinity, etc., by W. Adam, London, 1845, p. 419, footnote.

[4] Mining Almanack for 1850, by W. English, London, p. 220.

his Elements of Geology in 1865, remarked, "these phenomena and their causes (probably connected with electrical action) seem scarcely to have attracted the attention they deserve." In subsequent editions this suggestion of a connection with electrical action was omitted.

Mr. Leonard Maltby, of the Mill Dam Mine, Great Hucklow, informs me[1] that he has had experience of the explosion of slickensides. The explosions take place at the present time in the vein at the Cockersfield Shaft; pieces of mineral burst from the face with a loud noise and with great force, so as to necessitate great care on the part of the men when working. There are also several other places in the Mill Dam Mine where slickensides of an explosive tendency have occurred, as well as in the Silence Mine on the same vein, and in a vein near Eyam, called the Brookhead Vein. At the Lady Wash Mine also, on the eastern range of the vein worked at Mill Dam, the miners noted the same phenomenon. Its prevalence in this neighbourhood leads Mr. Maltby to infer that slickensides will explode more or less, while being cut, wherever they occur. He remarks further that where slickensides occur, the vein is always as hard and fast as it is possible to be, and seems to be under great pressure. "When we work with a pick, cutting one side of the vein, as soon as we have made a little opening, it seems then that the air gets in, and the mineral swells and bursts off with loud noises, and where the vein is hardest and most nipped, the explosions are strongest. It always bursts off just as far as the opening is made." He considers both the slickenside and the explosions to be the result of pressure.

Though some of the veins in which explosions have occurred contain much fluor-spar, yet the phenomenon has been more frequently observed in the hard and tight veins which contain calc-spar, heavy spar (sulphate of baryta) and galena. Fluor-spar, as Mr. Maltby informs me,[2] occurs more commonly in soft veins, such as that at the Dusty Pits, near Eyam, where it was very abundant. In this vein no slickenside was seen and explosions were unknown.

The late Mr. J. A. Phillips, F.R.S., F.G.S., etc., informed me that he had known of several instances of the flying off of fragments of mineral from the slickensided face of a vein, with a sharp report. In one case a fragment was thrown off with sufficient force to break the leg of a man who was passing. The explosions occurred after a portion of the vein had been undercut. Mr. Phillips suggested that the removal of one side of a vein would leave the remaining side in a condition of strain, resembling that of a strung bow, with a tendency to bulge outwards into the workings. The undercutting would free, so to speak, one end of the bow.

Mr. W. Bowman, of Alport, writes[3] that he has seen pieces of limestone in the Ecton Mine fly off with a sharp small crack, some short time after it has been broken by blasting. In one instance, in 1885, two miners were drilling a hole by hand in the Clayton Adit-level, when a piece of rock burst from the face with a loud report,

[1] In a letter dated 22nd October, 1886.
[2] In a letter dated 23rd November, 1886.
[3] In a letter dated 15th October, 1886.

throwing the men to the ground, and bruising them considerably; the thickness of the fragment was equal to the depth of the drill-hole, namely, ten or twelve inches. The toadstone also has been known by Mr. Bowman to break off with a little noise soon after it has been relieved of pressure by excavation. Ecton Mountain is composed of the upper beds of the Carboniferous Limestone, sharply contorted and crushed.

I may refer here also to the description by Mr. W. H. Niles,[1] of the movements of rocks resulting from lateral pressure, and exhibited in quarries. It was found at Monson that the rock has been brought into a compressed condition by a powerful lateral pressure acting in a north and south direction, and that, when opportunity is presented, the compressed rock expands with great energy, often bending, folding, and fracturing the beds, and sometimes producing sudden and violent explosions, and occasionally throwing stones into the air. The expansion became apparent on cutting trenches in the rock in an east and west direction.

At Lemont, Illinois, the bed of rock forming the floor of a quarry was gradually bent up into the form of an anticlinal, trending east and west, and running for about 800 feet with an elevation of six to eight inches. The elevation had taken place in consequence of the removal of the overlying rock, and had been attended by explosive sounds, and sometimes fragments of the rock had been thrown into the air. In the same quarry it was observed that drill-holes bored through two layers of stone became displaced, the upper parts of the holes being no longer vertically over the lower parts. The effects of this force have been noticed at five different localities, ranging over five and a half degrees of longitude.

Mr. Niles refers also to explosions which have sometimes occurred in making railway-tunnels and other excavations, and which could not be accounted for as the results of any artificial power.

The tradition among miners that knockings may be heard underground, where ore exists, is well known, and has often led to the expenditure of much money. That subterranean noises are not uncommon has been proved beyond doubt, and the following account by a working miner is not without interest.[2]

"I have heard some Miners say that it is a Knocking they hear, Striking much like as when one in Boreing, not constantly but resting by Fits, and always seem to be at a distance from him. . . . I once Worked in a Groove not many Years ago, where two more Men wrought, they worked by yards at a deeper Level than I wrought at . . . One day I having some leasure at Work, it struck into my Head to go down to them, . . . but coming there I found no Body, which I did much Wonder at, since I well knew that no Body else wrought within my hearing. Next Day I told the Men how I was mistaken; see you there says one of them to the other, it is what

[1] The Geological Agency of Lateral Pressure exhibited by certain Movements of Rocks, Proc. Boston Soc. Nat. Hist. vol. xviii. p. 272 (1876); see also *ib.* vol. xiv. and Proc. American Assoc. for the Advancement of Science, vol. viii. p. 285, and vol. xxii. part ii.

[2] The Miner's Dictionary, by William Hooson, 8vo. Wrexham, 1747 (under the head Knocker).

we are used to hear; after some little Discourse, they told me that they had heard it very often, and (says they) not long before you came here, we was both at Work and heard a Noise, and we concluded it could be nothing but somebody coming down the Shaft, and in a little while, about the time they might be got to our first Sump-head, we presently heard as we thought, them throwing the Corves down the Sump; we heard 'em rattle so plain against the hard Sides, and amazed at such folly we came in hast up, where we found all things as we had left them when we came down without the least alteration, as we could discerne. Thus the Men.

"One Instance more may be of the same kind, where I have been acquainted, and 'tis this: I with others wrought in a certain Work about eighty Yards deep, the Shaft was Sunk in a great and loose Shack of Chirts, which sunk down to the Soles and much further for any thing we know, being exceeding loose, and not any openess seen throughout the whole Work, but the ways that were cut; the loosness of this Work was all the care to keep it up; yet what I Remark is, that the Workmen themselves, but more especially the Labourers, at the Sump-heads and in the Gates, have been often affrighted with such a Noise and dismal Rattle, as if sometimes the Shaft had run in, and at other times the Gates or Sumps; I have heard it my self, and have thought by the Noise, we had been all made fast, but by God's Blessing, never found one Stick of Timber disordered or out of its Place; one would think that the Noise might be caused by something running in some openness, or great Shack, but there was never any such seen in the whole Work; for altho' there were large and wild shaken Places, yet they were all full of loose small Chirts to the Day; . . . what these Noises are, we miners know not, but must leave them to the Disquisition of such learn'd Men as deal in those profound Matters; I mention it because Miners say that the Knocking is some Being, that Inhabits in the Concaves and Hollows of the Earth; and that it is thus kind to some Men of suitable Tempers, and directs them to the Ore by such its knocking, etc."

In some of the mines near Eyam, which have been referred to above, explosions of fire-damp have occurred from time to time, especially in those which were sunk through the Yoredale Shale into the Carboniferous Limestone, and in the water-levels which were driven long distances through the Millstone Grit and Yoredale Shale to drain the mines. References to such explosions occur in most of the authors quoted above, and in such terms as to show that they were clearly recognized as distinct from the explosions due to slickensides. I am therefore disposed to believe that the great explosion described by Whitehurst as having occurred in 1738 was due to slickensides, but that in the fifty years which had elapsed before Whitehurst wrote, the account of the effects had become considerably exaggerated, or more probably confused with the account of some explosion due to fire-damp.

It is difficult to understand the lifting of the barrel in the shaft, and the blowing of a man twelve fathoms perpendicularly, except

by an explosion of violent expansive power. It will be noticed that the cause of the great explosion of 1790 is distinctly stated by Mr. W. Watson, though writing nearly forty years after the event, to have been a slide joint of slickensides going across a vein.

By the kindness of Mr. Maltby I have been supplied with some specimens of the explosive ore from the Cockersfield Shaft of the Milldam Mine at Great Hucklow, near Eyam. The specimens consist of sulphate of baryta and galena arranged in more or less vertical but irregular ribs. The planes of slickenside are beautifully polished, so much so in places as to possess the reflective power of a looking-glass, but they show also the usual ribbing or striation which so strongly conveys the idea of slickenside having been produced by the rubbing of two surfaces together. The planes of slickenside were clearly formed after the filling in of the vein by the minerals mentioned above. They cut through the galena and baryta impartially, nor in any of the specimens in my possession is there any appearance of a rearrangement of the minerals having resulted from the existence of the plane of slickenside, except that the slickenside surfaces are slightly stained by iron oxide, or coated by a microscopically thin film of galena.

The spar in these specimens has the granular appearance of white lump sugar, and readily crumbles into a gritty powder. Whether this granular structure is the result of the explosions by which the specimens were detached, there is no evidence to show. The specimens themselves average from half an inch to three inches across, and are of all shapes. Attempts have been made to prepare microscopic sections across the planes of slickenside, but up to the present without success.

The first explanation that suggested itself to me was that the mass of rock, separating two planes of slickenside, was comparable to a huge sheet of very brittle glass, placed on its edge; a slight blow on the lower part of which might bring down the whole mass in fragments. This, however, provides no explanation of the explosive power, which is so clearly brought out in the above quotations.

Secondly, it will be familiar to all who have been in mines, that newly bared shale swells and crumbles on exposure to air and moisture. This is probably due in many cases to chemical processes set up in the mass of the rock, principally no doubt in connection with the salts of iron. It seemed conceivable that such processes, taking place within a brittle rock, might place it in a condition of strain, under which it would fly to pieces with a mere touch. But there is no sign of any chemical alteration having taken place in these explosive spars.

The explanation, which perhaps best satisfies the requirements of the problem, appears to be that the spars are in a state of molecular strain, resembling that of the Rupert's Drop, or of toughened glass, and that this condition of strain is the result of the earth-movements, which produced the slickensides.

V.—Woodwardian Museum Notes: on some Anglesey Dykes. I.

By Alfred Harker, M.A., F.G.S.,
Fellow of St. John's College.

IN the Woodwardian Museum is a collection of nearly a thousand rock-specimens made by Professor Henslow to illustrate his "Geological Description of Anglesea" (1821, Trans. Camb. Phil. Soc. vol. i. pp. 359–452, plates xv.–xxi.). Specimens of the principal dykes were submitted to the examination of Professor Cordier, and his remarks on them are quoted in Henslow's paper. As Cordier's determinations date from a time when thin slices of rocks were unknown, and but little attention has since been given to the dykes of Anglesey, it is believed that brief notices of some of the typical rocks from localities easily identified may have an interest for British geologists. As regards the mode of occurrence of the dykes and their effects upon the adjacent strata, little can be added to the accurate descriptions of Henslow, written at a time when the igneous origin of dykes was a proposition to be proved. The specimens are referred to by number in the memoir, and these numbers will be cited below in brackets [ ].

We begin with a few specimens from the numerous dykes exposed on the shores of the Menai Straits. In spite of some interesting variations, these rocks possess many characters in common. They strike usually in directions varying from S.E. to E.S.E., and often coincide with lines of faulting, which are at right angles to the general strike of the strata. The only direct evidence of their date of intrusion is that they sometimes cut through Carboniferous beds; but if it is allowable to correlate these dykes with others having a similar direction in the Anglesey Coal-field, we may infer from Sir A. Ramsay's reasoning that the whole are of pre-Permian age (Geology of North Wales, 2nd ed. p. 264).

Beginning near Beaumaris, we find in the green contorted schists between Gallows Point and Garth Ferry an enormous number of small dykes of generally compact appearance. The majority of them are not more than a foot or two in breadth, but some attain to about twenty feet. They frequently ramify, but show on the whole a parallel arrangement with an average bearing about S.E. by E. In some cases a certain relative movement of the rocks on opposite sides of a dyke can be verified. Making allowance for the varying sizes of the dykes and the modifications due to more rapid cooling near the edges, the rocks present a general community of megascopic characters; only two of Henslow's specimens have been selected for closer examination.

Dykes between Gallows Point and Garth Ferry.

[640.] Augite-andesite.—The hand-specimen shows a black, compact ground-mass containing numerous clear felspars in the form of parallelograms. These crystals are very flat, and have a marked parallel arrangement, as noticed by Cordier and Henslow. Under the microscope they are seen in cross-sections of elongated shape, 0·1 to 0·15 inch in length, and their fluxional arrangement is very

evident. The faces which give the felspars their tabular habit are the brachypinacoids, while the other forms present may be the macropinacoid and basal planes. The usual albite-twinning is seen, combined with the Carlsbad type: the extinction-angles seem to indicate labradorite. The crystals are often bent and partially fractured, but I have not observed any relation between these disturbances and the twin-lamellation. Besides the felspars are abundant crystals of magnetite; and the ground-mass is composed of felspar microlites, magnetite, and rounded granules of augite decomposing into a pale-green substance. In both the ground-mass and the larger constituents, the magnetite seems to be of rather earlier formation than the felspar.

[642.] Augite-andesite.—Henslow mentions this rock as "more remarkably fine-grained and tough than any other which I have met with in Anglesea." It is a contact specimen with a fragment of the green schist firmly adhering to it. Here the scattered felspars are smaller and occur more sparsely; they show little of the tabular habit and parallel disposition so striking in the preceding slide. The ground-mass too is a little finer; but with these exceptions the same description will suffice.

To illustrate the modifications of texture in different parts of one dyke, two specimens collected by Prof. Hughes have been sliced, They are from a dyke just south-west of Gallows Point.

Augite-andesite from marginal portion of dyke.—This is intermediate in texture between [640] and [642], and has the same general characteristics. The scattered felspars, however, have inclusions of magnetite, disposed chiefly along the twin-planes.

Dolerite from central part of the same dyke.—The slide exhibits rectangular sections of felspar, mostly lath-shaped and about 0·1 inch in length, magnetite in crystals giving quadrangular sections and in rods, and decomposed augite in ophitic plates. There is no ground-mass. The felspars show twinning by different laws. In some cases a crystal is divided by a line which may represent Carlsbad twinning into two halves, of which one shows lamellation on the albite and the other on the pericline type. The lamellæ are often interrupted.

Another of Prof. Hughes' specimens, from a dyke north-east of Garth Ferry House, may be styled a porphyritic dolerite.—This rock bears a close resemblance to the preceding, but differs from it in the fact that the magnetite occurs in imperfect crystals of later formation than the felspar. Besides the rectangular felspars there are a few of larger dimensions giving squarish sections. This rock shows more advanced decomposition than the others mentioned above. The augite, which appears to have formed ophitic plates, is entirely destroyed and replaced by the usual pale-green substance with confused scaly structure, and polarizing in low tints of grey and indigo. Patches of this 'viridite' inclose crystalline grains of calcite. Grains of secondary quartz are also plentiful, as well as magnetite dust and ferruginous specks. The felspars are almost opaque.

Cordier pronounced some specimens from this part of the Straits to be "dolerite. The pyroxene very evident, with *fer titané*." In the slides examined, however, the iron-ores never show forms characteristic of ilmenite, and no leucoxene occurs. The compact rocks are named "basaltic lava."

Cadnant dyke.—Between Garth Ferry and Menai Bridge we meet with the first large dyke, which occurs on the right bank of the little stream at Cadnant. This dyke is not marked on the Maps of the Geological Survey, but Henslow traced its course among the schists for some distance inland. He also found it on the Carnarvonshire shore, where it cuts Carboniferous strata. In the latter place the rock is less compact in texture than on the Anglesey side, and Henslow states that "none of the dykes which intersect the limestone and shale attain to so great a degree of compactness as the generality of those which are found among the schist." Three dykes having a similar strike to that at Cadnant are marked on the Survey Map south of Bangor Station, and a slide from one of these, at Glan Adda, has been examined. Cordier identified the Cadnant rock as "a true dolerite, having the ingredients, pyroxene, *fer titané*, and felspar well characterized."

[545.] Dolerite; a typical specimen from Cadnant.—To the eye the rock shows a moderately coarse-grained aggregate, in which the augites are conspicuous, moulding elongated crystals of felspar. Under a low objective the structure is seen to be holocrystalline and ophitic. The felspars occur in mostly elongated sections, showing a rather fine albite-twinning, combined with a concentric zonary banding, and sometimes twinning on the pericline law. From the extinction-angles they should be andesine or oligoclase. This rock exemplifies a character found in most other similar dykes in North Wales; the felspars appear to be of two generations, of which one is older, and the other newer than the bulk of the magnetite. The later felspars are distinguished by their imperfectly defined outline and more equal dimensions, their more marked zonary banding, and their greater clearness: their twin-lamellæ are usually very narrow and rather wide apart. A few prisms of apatite are seen. The magnetite in this slide is plentiful, and builds crystals of intricate branching shapes. The augite has the pale-brown tint common to that mineral in almost all North Welsh rocks. It moulds the other constituents, and never shows crystal boundaries. The prismatic cleavages are strongly marked, and there are ill-defined interpositions arranged in branching lines or planes. The chief secondary product is a yellowish-green, doubly refracting mineral, which pseudomorphs augite: secondary granular magnetite accompanies it in places. The dominant felspar is often almost opaque owing to alteration-products.

Porphyritic dolerite: Glan Adda, south of Bangor Station.—This dyke occurs on the same line as that at Cadnant, and may be briefly referred to for comparison. Here the earlier felspars have lath-shaped sections: the later ones are more equi-dimensional, and show the zones of different chemical composition very distinctly. The augite moulds the older felspars, but is of earlier formation than the

second generation, and sometimes shows crystal-outlines, the prism and pinacoidal planes. Iron-ores are abundant, chiefly magnetite; fine needles of apatite occur in the felspars; small scattered flakes of biotite are sparsely present. The latter mineral is met with in the Cadnant dyke [525], "a circumstance of rare occurrence in the dykes of Anglesea," (at least in those of the Menai Straits). The Glan Adda dyke has pink porphyritic felspars, which under the microscope show large squarish sections, much decomposed.

It will be noticed that all these dolerites correspond in character more closely to the andesitic than to the basaltic family: olivine I have not yet observed in the above rocks, though it may possibly be lost among the decomposition-products. This mineral occurs, however, in the Plas Newydd dyke described below.

[546.] Dolerite: near Four Crosses, on the north-western prolongation of the Cadnant dyke.—This specimen, to illustrate the more compact type of rock, is taken from the outer portion of the dyke, though not from the actual contact, where the andesitic *habitus* prevails. The magnetite is mostly older, but partly newer, than the felspar; it occurs in crystals showing the cube or octahedron, and in complex shapes related to those forms. The minuter grains often appear in star-like aggregates with sections exhibiting three bilobate rays: these are sometimes surrounded by a ring of finely granular magnetite. The felspars give elongated rectangular sections: the larger ones are often simple or once twinned, but fine twin-lamellation is also found. The pale-brown augite, in ophitic plates of varying extent, is mostly destroyed. As secondary products occur the usual "viridite," finely granular calcite, and clear quartz.

The dykes in the neighbourhood of Menai Bridge have not been sliced. They are dolerite, often with porphyritic felspars. They appear to be much decomposed, and contain a considerable amount of calcite and pyrites.

Plas Newydd dyke.—The largest dyke in this part of the island cuts through the lower beds of the Carboniferous Limestone series a little south of Plas Newydd, the seat of the Marquis of Anglesey. This dyke, 134 feet wide, occupies a probable line of fault bearing in a south-easterly direction: it is met with again on the opposite side of the Straits. In the nomenclature of Cordier's day the rock was described as "indubitable basalt, consisting of felspar and pyroxene," but the normal type is holocrystalline and granular.

[485.] Olivine-Dolerite; typical rock of the Plas Newydd dyke; a rather coarse-grained dolerite with marked ophitic structure.—The microscope reveals olivine in abundant rounded grains included in the augite. There is much secondary magnetite dust resulting from its decomposition. Magnetite occurs also in crystals, usually imperfect cubes; this and the olivine are the earliest formed constituents. The chief felspars are in elongated crystals showing finely repeated twinning and often concentric zoning; the extinction angles are moderately high, and would agree with labradorite. There is some slight bending of the crystals, which may perhaps affect the twin-lamellation. Sometimes cross-twinning, presumably on the pericline

law, is observed. There is also, as in the Cadnant dyke, a later generation of felspars, shapeless, but broader than the others. They are simple or once twinned, and between crossed Nicols show strong zonary shading: as usual they are clearer than the earlier felspars. The augite is in light-brown plates, moulding the dominant felspars: it shows branching layers of interpositions. The chief secondary products in this slide are a yellowish-green structureless substance and a ferruginous staining; both seem related to the augite.

[486.] Dolerite; the more compact portion of the dyke; a fine-grained ophitic rock with abundant magnetite, closely resembling [546] from the Cadnant dyke. The felspar is in elongated prisms, with mostly repeated albite-twinning and fairly wide extinction-angles. It is clear except for some granular calcite and fine viridite strings, following for the most part, the basal cleavage-cracks. Magnetite is plentiful in crystals, skeletons, and rods; and is slightly posterior to the felspar. The apparent rods, which are probably sections of plates, have a parallel disposition, and are arranged transversely to felspar crystals which they surround. A similar relation of magnetite to olivine is described by Reusch from the basalts of Jan Mayen.[1] The present rock contains also minute rings (spherical shells) of magnetite dust surrounding nuclei of the same. The augite, always allotriomorphic, has the same characters as in the preceding slide. Chloritic decomposition-products and clear secondary quartz occur.

The metamorphic effects of the Plas Newydd dyke upon the adjacent Carboniferous strata, as described by Henslow, possess considerable interest. On the south-west side a bed of calcareous shale, abutting upon the dyke, is converted into a kind of lydianite, containing calcite and clusters of garnet and analcime crystals. Henslow's specimens [511 to 523] show the development of these last-named minerals in every stage from mere whitish concretionary spots in the hardened shale to perfectly formed crystals. These are closely clustered together along particular bedding-planes, and sometimes the valve of a *Productus*, converted into crystalline calcite, is seen to be studded over and penetrated by globules or crystals of analcime.

The garnet occurs in crystals up to 0·7 inch in diameter, showing the faces of the rhombic dodecahedron (110), sometimes truncated by narrow planes belonging to the form (211): they have often a marked concentric zonary structure. They vary from yellowish-green to olive-brown, with a resinous lustre. "Their specific gravity is 3·353," and their hardness under 7. These characters indicate a variety approaching *grossularia*; Lyell[2] gives the percentage of lime as 20. A slice (cut from a specimen in the Sedgwick collection) shows a number of crystals in various stages of development, closely packed together, and the interstices filled with crystalline calcite. The crystals are not all isotropic: they contain a large amount of foreign material. The readiness with which garnets of considerable

[1] Cf. also Prof. Judd's basalt from Mull, Q.J.G.S. vol. xlii. pl. vi. fig. 7, 1886.
[2] Student's Elements of Geology, 3rd ed. p. 515.

size are formed by contact alteration is evidently connected with this capacity of the mineral for including in its crystals a large quantity of foreign matter. The same remark applies to disthene and chiastolite.

The analcime crystals, where they are best developed, show the faces of the trapezohedron (211), and have a concentric zonary structure. The specimens were analyzed by Cumming, who pronounced them to be "analcime with excess of iron." His figures, however, differ widely from published analyses of the mineral in question, and can only be reconciled by supposing the analcime to be partially changed into prehnite, a mode of alteration known to take place occasionally.[1] Assuming the iron to be present as ferric oxide, and replacing it by alumina, Cumming's analysis is represented by column I. below. The second column gives the composition of analcime calculated from the formula $H_4 Na_2 Al_2 Si_4 O_{14}$; the third prehnite from the formula $H_2 Ca_2 Al_2 Si_3 O_{12}$. Column IV. is the mean of II. and III.

	I.	II.	III.	IV.
Silica	49	54·4	43·6	49·00
Alumina	24	23·4	24·9	24·15
Lime.....	12	—	27·1	13·55
Soda	9	14·1	—	7·05
Water	5	8·1	4·3	6·20
	99	100·0	99·9	99·95

It will be seen that the Plas Newydd mineral agrees fairly well with the composition of analcime half-converted into prehnite. That such a mineral as analcime should be formed as a true contact-alteration product appears at first very improbable, but the whole process of development can be seen in the specimens, and is precisely similar to that of the garnets.

Moel-y-don and Plas-Coch dykes.—Several dykes, one forty feet in width, were noted by Henslow at Moel-y-don, opposite what is now Port Dinorwic. These are not marked by the Geological Survey, and I have failed to find any exposures on the shore. Others occur inland on about the same line, near Plas-Coch.

[563.] Amygdaloidal dolerite from one of the minor dykes, south of Moel-y-don: a medium-grained ophitic dolerite, with numerous spherical cavities, averaging 0·1 inch in diameter, filled with secondary minerals, and others larger and more irregular in shape. Under the microscope the dominant felspars are seen in elongated sections with ragged ends due to some of the twin-lamellæ projecting beyond others. Between crossed Nicols they show for the most part finely repeated albite-twinning, and some zonary shading. Some sections perpendicular to the twin-plane give extinction-angles up to about 38°, indicating anorthite. The smallest crystals are once twinned, and in several places have a radiate arrangement about a centre. Besides these earlier-formed felspars, there is a second generation, less abundant and, judging roughly from their

[1] Blum., "Pseudomorphosen," p. 100, etc.

extinctions, of a more acidic species. These are untwinned, and show the zones of growth very clearly. They are without crystal boundaries, and sometimes include little crystals of the older generation. Magnetite occurs in small cubes of later formation than the first set of felspars: it is not very abundant. The augite in pale-brown patches moulds or completely includes the felspars of the earlier generation. In some places it is crowded with short black rods, probably of magnetite, disposed parallel to two definite directions: this appears to be a secondary phenomenon connected with the decay of the augite. The usual feebly polarizing 'viridite' patches replace this mineral, and there is some calcite dust in the slide. The infilling of the vesicles has taken place in several distinct stages. First a zeolitic mineral has been deposited at points on the wall, in fan-like bundles of imperfect crystals. The interior of the cavity, thus reduced in size, has been stained by a greenish-yellow substance, and then lined with chalcedony in the usual mamillary coating. The remainder of the vesicle has finally been filled with calcite, not in one mass, but as a mosaic of distinct crystalline grains, mostly untwinned. In some cases a little clear quartz occurs with the calcite.

Llanddwyn dykes.—Henslow collected specimens from two dykes in the island or peninsula of Llanddwyn, westward of the opening of the Menai Straits. They do not agree in position with those marked on the Survey Map. The rock is much decomposed, and only one slide has been prepared.

[684.] Porphyritic dolerite from Llanddwyn.—This is a fine-grained, much-weathered rock inclosing liver-coloured felspars more than an inch in diameter. One of these is shattered, but the parts still remain in proximity to one another. The microscope shows abundant cubes of magnetite, small felspar prisms much altered, and augite replaced by the characteristic pale-green product with some calcite. There is a small vesicle filled by a deposit of quartz followed by calcite with polysynthetic twinning. The large porphyritic felspars are deeply affected by an apparently saussuritic alteration. In some places, however, they are clear enough for their finely repeated twinning to be made out, and the extinction-angles are such as would be given by labradorite. Similar felspars occur in the Glan Adda dyke already mentioned.

All the dykes of the Menai Straits, with perhaps the exception of the olivine-bearing rock of Plas Newydd, are intermediate rather than basic in their affinities. The characters of the augite are in accordance with this; so also the frequent cross-twinning in the larger felspars and their very pronounced zones of growth, the abundance of magnetite to the exclusion of ilmenite, and the nature of the ground-mass where it occurs. The rocks are all 'porphyritic' in the sense of Rosenbusch, since they contain felspars of more than one generation. When the later felspars occur as microlites forming part of a ground-mass, I have used the name *augite-andesite*. Rocks of more holocrystalline type, in which the two sets of felspars are of about equal size, have been called *dolerites*, as distinguished from

diabases, which are characteristic of larger intrusive masses, and exhibit the 'granular' structure of Rosenbusch. The term *porphyritic dolerites* has been applied to those containing larger scattered felspars, making in all three generations.

The dykes of the central and northern portions of Anglesey and of Holyhead Island differ widely from those described above, and may furnish the subject of further notes.

REVIEWS.

I.—The Fossil Fishes of the Chalk of Mount Lebanon, in Syria. By James W. Davis, F.G.S., F.L.S., etc. Scientific Trans. Royal Dublin Soc., series 2, vol. iii. pp. 457–636, pls. xiv.–xxxviii. (April, 1887.)

AGAIN we have to welcome from the pen of Mr. James W. Davis an important contribution to our knowledge of the palæontology of Fishes. Nearly four years ago (Geol. Mag. Nov. 1883) we received an exhaustive monograph upon the fossil fish-remains of the Carboniferous Limestone of Britain, in which were figured and described a number of teeth and spines, indicative of types previously unknown to science; and on the present occasion, a still more substantial contribution is made in the form of figures and descriptions of a large series of the most perfectly preserved fossil fishes that have hitherto been discovered. The author treats of the palichthyology of the Upper Cretaceous rocks of the Lebanon, as revealed by the researches of the Rev. Prof. E. R. Lewis, formerly of the Syrian Protestant College, Beyrout, whose magnificent collection was acquired some years ago by Mr. R. Damon, of Weymouth, and a large portion of which has now been purchased by the British Museum. This memoir, like the previous one, was communicated by the late Earl of Enniskillen to the Royal Dublin Society, and is printed and published in the excellent style for which that Society's Transactions are so well known.

On glancing over the pages, we are led to admire the industry and untiring energy of the author, who succeeds, in the midst of business avocations and at so great a distance from works of reference, in turning hours of leisure to such profitable account. Nearly all the more important memoirs bearing upon the subject have been consulted and are referred to, and, in addition to notes upon forms already known, no less than ten genera and sixty-six species are described as new to science. At the same time, the pursuit of scientific study under such conditions must necessarily render one liable to errors arising out of the very difficulties surrounding work requiring so much research as the present; and to this cause must probably be ascribed certain misapprehensions that will doubtless be criticized adversely by ichthyologists more favourably situated for interpreting these remains.

Mr. Davis prefaces his work with a concise and appropriate introductory section, historical and geological. This is mainly based

upon the *resumé* already published by Pictet and Humbert, with the addition of a notice of works that have subsequently appeared. By some singular mishap, however, there is no reference to Prof. Lewis's own interesting account of the geology of the Lebanon, which appeared in the GEOLOGICAL MAGAZINE in 1878; and the omission is all the more unfortunate, since the observations contained in this paper were made while collecting the fossils which chiefly form the subject of the memoir before us.[1]

Proceeding to the systematic portion of the work, the author wisely decides to follow some definite published classification, and selects that of Dr. Günther employed in the well-known "Study of Fishes." We can scarcely agree with Mr. Davis, however, when he states that this system "embraces the most recent work of modern embryologists and anatomists;" and we venture to think that some of the new facts revealed by the Lebanon fishes themselves will combine with other recent discoveries to demonstrate the illogical nature of the arrangement.

The descriptions of the Selachian fishes occupy 24 pages and seven plates, and relate to a magnificent series of specimens representing 9 genera and 16 species, of which 2 genera and 12 species are considered to be new. A very fine nearly complete example of *Notidanus* is made known under the name of *N. gracilis*. Two new Scylliidæ are referred to *Thyellina*. Of the Spinacidæ, there are remarks upon *Spinax primævus*, and the description of a novelty, *Centrophoroides latidens*, closely related to *Centrophorus*; but the author unfortunately fails to appreciate the essential characters of this family, and includes a remarkable new genus, *Rhinognathus*, which is described as possessing a distinct anal fin. The teeth of the latter, if found isolated, would have been unhesitatingly referred to *Lamna*, and the discovery of the complete fish to which they belong is thus of especial interest. Among Rays, the Rhinobatidæ are believed to be represented by six species of *Rhinobatus*, of which five are new and most beautifully preserved; a large *Cyclobatis* is described as *C. major*; and a diminutive fossil from Sahel Alma is doubtfully assigned to *Raja*. The Chalk of Mount Lebanon has thus yielded one of the most important series of Sharks and Rays ever discovered in a single formation, and the accession of new forms is unusually great. On reading the letterpress, however, accompanying the plates, we cannot but regret the want of scientific precision in regard to anatomical points. The branchial arches, for example, are continually described as "branchiostegal rays"; the basal pterygia of the pectoral fins are referred to as part of the scapular arch, being, in *Rhinobatus*, "divaricating osseous plates," and in one case "protecting the gills"; the shagreen is regarded as a "cuticular" covering; and in the description of the fine skull of *Rhinobatus tenuirostris* on p. 488, the most evident features are overlooked.

Some interesting novelties are made known among the Ganoids, which comprise two species of the Pycnodont *Palæobalistum*, and

[1] See The Fossil Fish Localities of the Lebanon by the Rev. Prof. E. R. Lewis, M.A., F.G.S., 1878, Decade II. Vol. V. pp. 214-220.

two forms perhaps having some affinity with *Amia*. In the determination of *Palæobalistum Goedelii*, Heckel, the author has apparently followed Mr. William Davies' labelling of the National fossils without consulting Heckel's original description; for there is no reference to the latter, and it is wrongly assumed (p. 496) that the species was not at first described from the Lebanon. With the exception of certain head bones, almost the complete skeleton of this fish is shown in the new specimens; and there is also good evidence of a second species, which Mr. Davis names *P. ventralis*. The two remaining Ganoids are known only by portions of the caudal region, and so cannot be satisfactorily placed; they are described as *Spathiurus dorsalis* and *Amphilaphurus major*. With the same order are also associated a decidedly Teleostean caudal fin, curiously determined to be "*Chondrosteus ?*" and another small fish "*Microdon? pulchellus*," which does not appear even remotely connected with the Pycnodonts.

Passing to the Teleosteans, there are some brief remarks upon the Sparoid genus, *Pagellus*, and then follows a most interesting account of the Berycidæ. One new species of *Beryx*, two of *Pseudoberyx*, two of *Hoplopteryx*, and one doubtful species of *Homonotus*, are described; and the author adds some appropriate remarks upon the mixture of extinct fishes originally referred to the first of these genera. He shows (so far as we are aware, for the first time) that the so-called *Beryx Zippei*, *B. superbus*, and *B. syriacus*, ought all to be placed in the genus *Hoplopteryx*; and this is an important advance towards the philosophical arrangement of the extinct members of the family.

The only representatives of the Carangidæ are referred to *Platax*, and of this genus two species are distinguished, the one named *P. minor* by Pictet and Humbert, and the other new, described as *P. brevis*. Some family-headings, however, have been accidentally omitted from the text, and *Petalopteryx*, *Cheirothrix*, and *Sphyræna*, thus fall under the section Carangidæ. Of the first of these, Mr. Davis has only observed a single specimen, referable to a new species; but of the second, some five examples are described. The latter are said to have no less than fifty vertebræ, and other features combine to render their association with the Gobioids somewhat problematical. *Sphyræna Amici*, Agassiz, is rightly dismissed as founded upon uncertain evidence.

Of the Fistulariidæ, a fine specimen of "*Solenognathus*" *lineolatus*, Pict. et Humb., is figured; but the author omits to substitute a new generic name for the one it bears, so long pre-occupied. Next succeeds a lengthy account of the characteristic Lebanon Cretaceous genus, *Pycnosterinx*. Mr. Davis agrees with Pictet and Humbert in placing this form with the Chromides, and recognizes five species in addition to the six already known. These are mostly described in detail; but it would have been interesting to have further information regarding the fish named *P. latus* (pl. xxvii. fig. 2), which appears to possess a remarkably primitive tail. In the same family is also placed *Imogaster auratus*, Costa, of which a beautiful new species is made known; and another example of the Italian Professor's *Omosoma Sahel-Almæ* is referred to the Stromateidæ.

The Physostomous fishes are placed in the families of Siluridæ, Scombresocidæ, Esocidæ, Halecidæ, Hoplopleuridæ, and Murænidæ. The first of these becomes a convenient "refuge" for two remarkable genera, whose characters appear to be unique. *Coccodus* has already been so determined by Pictet, and the new materials described by Mr. Davis add very materially to our knowledge of the skeleton of the fish. There is an anteriorly directed spine upon the top of the head; the body seems to have been scale-less; and the notochord persistent. Another fish, known only by a single specimen, destitute of the head, is named *Xenopholis carinatus*, and presents very different characters. The body is covered with imbricating bony scutes; the dorsal and anal fins are long and opposite, and the latter possesses two small robust spines in front; while the pelvic fins are abdominal, consisting of 12 or 13 rays, all soft.

Of the Scombresocidæ, a small flying fish is described under the new generic name of *Exocœtoides*, and considered to be closely allied to the living *Exocœtus*. Beautiful specimens are figured, showing all the more characteristic features of the genus. Another interesting novelty is a well-preserved example of *Istiæus* from Sahel Alma,—a form hitherto only discovered in the Upper Cretaceous of Westphalia. This is named *I. lebanonensis*, and Mr. Davis follows Agassiz and W. von der Marck in assigning the genus to the Esocidæ.

The great families of Salmonidæ and Clupeidæ are next treated together under Agassiz's convenient name of Halecidæ. Six new species of *Osmeroides* are determined; one of *Sardinius*; one of *Opistopteryx*; five of *Clupea*; and one doubtful species of *Engraulis*. There are also two new forms of *Spaniodon*. The section upon *Osmeroides* commences with a general notice of the genus, particularly referring to the important researches of W. von der Marck, but unfortunately omitting a reference to Laube's recent remarks upon the skeletal anatomy of the first (Denkschr. Akad. Sci. Wien). The species are then carefully described in detail, with numerous illustrative figures; and two specimens are interesting as showing well-preserved ova, though the author does not appear to have recognized these, merely noting them as "masses of rounded granular substance spread over the abdominal region." *Sardinius crassapinna* is another important new member of the Lebanon Chalk fauna; and the type specimen of *Opistopteryx curtus* exhibits the skeleton of the latter genus in an unusually perfect state. Proceeding to the long series of species of *Clupea*, we hardly feel convinced of the propriety of assigning some of the forms described to this genus; *C. Lewisii*, for example, has a remarkably Elopine aspect, and there are others whose connection with *Clupea* does not, at first sight, seem well established. Closely related to these is *Leptosomus*, of which Mr. Davis has found nothing to add to the original descriptions. Some notes on *Chirocentrites* follow, and then an interesting detailed account of the species of *Spaniodon*, and of a nearly allied fish believed to represent a new genus, *Lewisia*.

The remainder of the Halecidæ are referred to this group with more hesitation. The author removes to this position the remarkable

genus *Eurypholis*, from its more usual place in the Hoplopleuridæ, adding one new species, and showing that Pictet's *E. longidens* must be regarded, at least in part, as representing a hitherto unrecognized genus, for which he proposes the name of *Eurygnathus*. This is a fish of extreme interest, as are also two others referred to new genera, *Pantopholis* and *Phylactocephalus*. These forms belong to a type apparently well represented in Cretaceous seas, and are suggestive of some interesting considerations in regard to the affinities of the primitive Teleosteans of later Mesozoic times, to which, it is to be hoped, the author will return in greater detail on some future occasion. We would wish to know something further, for example, concerning the obvious connection between *Eurygnathus* and *Enchodus*—especially as Prof. Cope, so long ago as 1875, showed that the latter was a truly Physostomous fish, having no affinities with the Trichiuridæ, as previously supposed, and is still erroneously maintained in the monograph before us.

A large number of fine specimens of *Rhinellus* are described, indicating no less than six new species, and the author then proceeds to consider an equally unique series of *Leptotrachelus*, representing the family of Hoplopleuridæ. These fossils are preserved in the British Museum, and reveal almost all the hard parts of the fish. *L. triqueter* is described in great detail, and Mr. Davis makes known a new variety of this form, in addition to another, which is considered specifically distinct. He also gives reasons for concluding that no true *Dercetis* has been found in the Lebanon Chalk, and that Pictet's *D. linguifer* was probably founded upon a fragment of *Leptotrachelus triqueter*. A figure of *Aspidopleurus cataphractus* is likewise added, and this genus included in the same family.

In conclusion, Mr. Davis makes an important contribution to philosophical ichthyology by bringing forward the first evidence hitherto discovered of a Mesozoic eel. Two species, referred to *Anguilla*, are figured and described, the one from Hakel and the other from Sahel Alma; and the specimens are fortunately sufficiently complete to leave not the slightest doubt as to their family relationships.

As will be gathered from this brief *resumé*, the author is to be congratulated on having contributed to fossil Ichthyology one of the most extensive works of recent years; and its value is doubly enhanced by the careful drawings of Miss E. C. Woodward, who has executed the fine series of illustrative plates. A. S. W.

II.—Sunlight. By the Author of "The Interior of the Earth." Second Edition. pp. 180. (London, Trübner and Co., 1887.)

IN this little work the author (Mr. H. P. Malet) asks for the "serious consideration" of his "simple suggestion, that light was the first cause of the creation of this earth, acting on a nebulous mass that held in it gases or material sensitive to, absorptive, and retentive of that light." "In other words, a nebulous, chaotic mass was converted into air, water, and solids by the action of sunlight on gases sensitive to that force." He finds that there is actually no

proof of heat in the sun, nor that this earth was ever hot; but that the "solids contracted and subsided in their necessary gravitation, and the waters certainly subsided with the bed they rested on. As the entire solid body could not possibly sink into a smaller space than it occupied, it followed that the water sank into the lower levels of its bed, and left ridges and islands all round the sphere to form the dry land." This sinking of the ocean-bed is one of the main contentions of the author: "the process has been going on ever since organic life began; therefore we find the relics in our quarries, mines, and on our mountain tops." It is needless to criticize these statements, for although made by one who has read or consulted some standard geological works, he has evidently failed to grasp the principles and philosophy of the science. We can only lament the publication of books of the class to which "Sunlight" belongs, for they are calculated to do much harm to those who cannot discern fact from fiction. The author, quoting remarks of Mr. Froude, asks, "How many times must we outsiders learn our science and then unlearn it? Each generation of philosophers laughs at the conclusions of its predecessors." In questions relating to Cosmogony science is naturally speculative, and the most eminent men differ on many points; but it is curious to find the author quoting from that "lover of truth," Dr. Kinns, and criticizing some of his statements about the early history of the earth.

We do not find so much fault with the author for his quotations to show how various geologists "ancient and modern" differ one from the other on speculative matters; we find most fault with his own geological (?) teachings. The following quotations will suffice to justify our lamentations. "It is asserted that rocks are scratched, grooved, and polished by ice-friction." And the author proceeds as follows, "I have examined many of these places, and take a type in Lucerne. The polishing was all done by running water; the small scratches and the larger grooves were all done first by sand and water; then as they increased in size gravel and pebbles made them into grooves. Some of these follow bends in the rock, which ice could not have done." Again, in reference to Caverns, the author remarks, "To prevent any confusion, I divide caves into three heads —First, those that have been excavated by man or beast; secondly, those that have been washed out by water; thirdly, those that have been built on a centre or nucleus." In reference to the third cause for caves he goes on to say, "They are built as a nucleus on a centre support, and are similar in history, but not in extent, to those coal-fields which have ocean deposits over each seam." While, however, we take exception to these and many other statements, we entirely sympathize with one sentence in the work before us, "We require correct data to start from, before puzzling students of natural history by one thing to-day and another to-morrow, thus throwing cosmogony into chaos, and making scientific teaching untrustworthy."

REPORTS AND PROCEEDINGS.

Visit of the Geologists' Association to the Historical and Type Collections in the Geological Department, British Museum (Natural History), Cromwell Road, S.W.

ON Saturday afternoon, the 12th of March, 1887, the Members of the Association, accompanied by their President, F. W. Rudler, Esq., F.G.S., their Secretaries Dr. J. Foulerton, F.G.S., and B. B. Woodward, Esq., F.G.S., assembled in the Central Hall of the Natural History Museum, Cromwell Road, whence they proceeded, under the guidance of Dr. Henry Woodward, F.R.S., the Keeper of the Department of Geology, to visit a newly-opened Gallery (No. 11), in which had been arranged, in seventeen cases, a series of nine Collections of historical and palæontological interest, bearing upon the early history of the British Museum and the study of Geology and Palæontology in this country. Dr. Woodward addressed the members as follows:—

Taking the exhibition cases in *chronological order*, the earliest is the "Sloane Collection." This is the most ancient portion of the Geological Collection, having formed a part of the Museum of Sir Hans Sloane, Bart., F.R.S., acquired by purchase for the Nation in 1753.

The geological specimens are stated to have consisted "in what by way of distinction are called *extraneous fossils*, comprehending petrified bodies, as Trees or parts of them; Herbaceous plants; Animal substances," etc., and reported to be "the most extensive and most curious that ever was seen of its kind." Until 1857 the Fossils and Minerals formed one collection, so that a large part of the "Sloane Collection" consisted probably of mineral bodies and *not organic*, but in any case only about 100 specimens of invertebrate[1] fossils can now be identified with certainty as forming part of the original Sloane Museum. Each specimen in the Sloane Collection had originally a number attached to it, corresponding to a carefully prepared Manuscript Catalogue, still preserved, which contains many curious entries concerning the various objects in the Museum. In the course of more than 130 years, many of these numbers have been detached from the objects or obliterated by cleaning. But as all fossils at this early date were looked upon *merely as curiosities*, but little attention was paid to the formation or locality whence they were derived. Historically, the collection has immense interest to us, marking the rapid strides which the science of Geology has made of late years, especially as regards its more careful and systematic methods of study.

The next Collection in chronological order is the "Brander Collection," and is the earliest one in which types of named and described species have been preserved.

This Collection was formed by Gustavus Brander, F.R.S., F.S.A., in the earlier half of the last century, and an account of the same, with eight quarto plates, was published in 1766, entitled, "Fossilia

[1] And some few vertebrate fossils which have not been separated from the General Collection.

Hantoniensia Collecta, et in Musæo Britannico deposita." The descriptions of the species given in the work were written by Dr. Solander, one of the Officers of the British Museum. They were "collected in the County of Hampshire, out of the cliffs by the sea-coast between Christchurch and Lymington, but more especially about the cliffs by the village of Hordwell, nearly midway betwixt the two former places" (*op. cit.* p. 111).

Only a small number out of the original 120 figured specimens, are now capable of being identified, the rest having become, in the course of 120 years, commingled with the far more numerous and later Eocene Tertiary acquisitions, and so have lost their connection with this admirable Memoir. The engravings of the shells are equal to any modern published work descriptive of the fossils of the Eocene formation; but the names given by Dr. Solander are in many instances incorrect, according to our present knowledge of the genera of Mollusca.

The next series to which I would direct your attention is the Collection of William Smith, LL.D. This Collection, which was commenced about the year 1787, was purchased by the Trustees in 1816, a supplemental Collection being added by Dr. Smith in 1818.

It is remarkable as the first attempt made to identify the various strata forming the solid crust of England and Wales by means of their fossil remains. There had been other and earlier Collections of fossils, but to William Smith is due the credit of being the first to show that each bed of Chalk or Sandstone, Limestone or Clay, is marked by its own special organisms and that these can be relied upon as characteristic of such stratum, wherever it is met with, over very wide areas of country.

The fossils contained in this Cabinet were gathered together by William Smith in his journeys over all parts of England during thirty years, whilst occupied in his business as a Land Surveyor and Engineer, and were used to illustrate his works, "Strata Identified by Organized Fossils," with coloured plates quarto (1816; four parts only published): and his "Stratigraphical System of Organized Fossils" (quarto, 1817).

A coloured copy of his large Geological Map, the first Geological Map of England and Wales, with a part of Scotland, commenced in 1812 and published in 1815—size 8 feet 9 inches by 6 feet 2 inches wide, engraved by John Cary—is exhibited in the last Wall-case on the right hand side of this Gallery, at the north end. It is well worthy of careful inspection.

William Smith was born at Churchill, a village of Oxfordshire, in 1769; he was the son of a small farmer and mechanic of the same name, but his father died when he was only eight years old, leaving him to the care of his uncle, who acted as his guardian, William's uncle did not approve of the boy's habit of collecting stones ("pundibs" = *Terebratulæ*, and "quoit-stones" = *Clypeus sinuatus*); but seeing that his nephew was studious, he gave him a little money to buy books. By means of these he taught himself the rudiments of geometry and land-surveying, and at the age of

eighteen he obtained employment as a land surveyor in Oxfordshire, Gloucestershire, and other parts, and had already begun carefully and systematically to collect fossils and to observe the structure of the rocks. In 1793 he was appointed to survey the course of the intended Somersetshire Coal-Canal, near Bath. For six years he was the resident engineer of the canal, and, applying his previously-acquired knowledge, he was enabled to prove that the strata from the New Red Marl (Trias) upwards followed each other in a regular and orderly succession, each bed being marked by its own characteristic fossils, and having a general tendency or 'dip' to the south-east.

To verify his theory he travelled in subsequent years over the greater part of England and Wales, and made careful observations of the geological succession of the rocks, proving also, by the fossils obtained, the identity of the strata over very wide areas along their outcrops.

His knowledge of fossils advanced even further, for he discovered that those *in situ* retained their sharpness, whereas the same specimens derived from the drifts or gravel-deposits were usually rounded and water-worn, and had reached their present site by subsequent erosion of the parent-rock.

In 1799 William Smith circulated in MS. the order of succession of the strata and imbedded organic remains found in the vicinity of Bath.

His large Geological Map of England and Wales is dated 1815.

On June 1, 1816, he published his "Strata identified by Organized Fossils," with illustrations of the most characteristic specimens in each stratum (4to.).

In 1817 he printed "A Stratigraphical System of Organized Fossils," compiled from the original geological collection deposited in the British Museum (4to.).

In 1819, he published a reduction of his great Geological Map, together with several sections across England.

These have just been presented to the Museum by Wm. Topley, Esq., F.G.S.

Mr. Smith received the award of the *first* Wollaston Medal and fund in 1831, from the hands of Prof. Sedgwick, the President of the Geological Society.—"As a great original discoverer in English geology, and especially for his having been the first, in this country, to discover and teach the identification of strata, and to determine their succession by means of their imbedded fossils."

In June, 1832, the Government of H.M. King William the Fourth awarded Mr. Smith a pension of £100 a year, but he only enjoyed it for seven years, as he died 28 Aug. 1839.

In 1835 the degree of LL.D. was conferred upon Mr. Smith by the Provost and Fellows of Trinity College, Dublin.

Perhaps the highest compliment paid him was that by Sedgwick, who rightly named him "the Father of English Geology."

The bust above the case which contains William Smith's collection is a copy of that by Chantry surmounting the tablet to his memory in the beautiful antique church of All Saints at Northampton, where his remains lie buried.

We come next to a collection, the very name of which betrays the antiquity of its origin. It is known as "Sowerby's Mineral Conchology."

This Collection was begun by Mr. James Sowerby, prior to 1812, and continued by his son, Mr. James de Carle Sowerby, F.L.S., during the preparation of their great work entitled, "The Mineral Conchology of Great Britain," which appeared in parts, between June, 1812, and December 1845, and forms six volumes octavo, illustrated with 648 plates.

The value of the work consists in the fidelity and accuracy of the figures given, and also that most of the specimens drawn are here named and described for the first time. They comprise fossils from all parts of England and from every Geological formation.

The small green labels mark the specimens actually figured in the work. The Collection was purchased by the Trustees from Mr. J. de Carle Sowerby, January, 1861.

It may be interesting to record that many of the latter parts were illustrated by plates drawn by the late Mr. J. W. Salter, A.L.S., F.G.S., for so many years palæontologist to the Geological Survey. When a youth, Salter was apprenticed to Mr. J. de Carle Sowerby, F.L.S., who was at that time both a naturalist and an engraver. The youthful apprentice afterwards married his master's daughter, and became, as is well known, one of the most brilliant palæontologists in this country.

Another curious, but small series represents the 'types' or 'figured specimens' of "König's *Icones Fossilium Sectiles.*"

This illustrated work, on miscellaneous fossils in the British Museum, was prepared by Mr. Charles König, the first Keeper of the Mineralogical and Geological Department, after its separation from the general Natural History Collections in 1825.

The engravings are rough, but characteristic, and the first "Century" (or 100 figures of fossils), is accompanied by descriptions; the plates of the second "Century" have names only, but no descriptions are published with them.

A far more important Collection is that known as "The Gilbertson Collection."

In 1836 Prof. John Phillips published Vol. II. of his "Illustrations of the Geology of Yorkshire," which is devoted to the "Mountain Limestone District." In the Introduction he writes as follows:—"My greatest obligation is to Mr. Wm. Gilbertson of Preston, a naturalist of high acquirements, who has for many years explored with exceeding diligence a region of mountain limestone, remarkably rich in organic remains. The collection which he has amassed from the small district of Bolland is at this moment unrivalled, and he has done for me, without solicitation, what is seldom granted to the most urgent entreaty; he has sent me for deliberate examination, at convenient intervals, THE WHOLE OF HIS MAGNIFICENT COLLECTION, accompanied by remarks dictated by long experience and a sound judgment." He (Gilbertson) had proposed to publish on the *Crinoidea* himself, but his sketches as well as his specimens were

all placed at Prof. Phillips's disposal. Phillips adds—"An attentive examination of this rich collection rendered it unnecessary to study minutely the less extensive series preserved in other cabinets . . . . *most of the figures of fossils are taken from specimens* in Mr. Gilbertson's Collection, because these were generally the best that could be found."

The Gilbertson Collection was purchased for the British Museum in 1841.

The collections which follow mark a distinct era in the annals of Geological Science.

Some forty-seven years ago a little society was founded by a few London geologists, namely—Dr. J. Scott Bowerbank, F.R.S., Searles V. Wood, F.G.S., Prof. John Morris, F.G.S., Alfred White, F.L.S., Nathaniel T. Wetherell, F.G.S., James de Carle Sowerby, F.L.S., and Frederick E. Edwards, F.G.S., for the purpose of illustrating the Eocene Mollusca, and entitled the "London-Clay-Club."

They met at stated periods at each other's houses, and after a time they said, "Why should we not illustrate all the fossils of the British Islands, and from every formation?" No sooner proposed than a society was founded, called the Palæontographical Society, in the year 1847 (just forty years ago). The first volume, issued in that year, was "The Crag Mollusca, Part I., Univalves," by Mr. Searles V. Wood, F.G.S. (with 21 plates).

You have here before you the actual "Searles Wood Crag Collection." This collection was commenced in 1826, and occupied about 30 years in its formation. It represents the Molluscan fauna of the Red and Coralline Crags of the neighbourhood of Woodbridge, and from Aldborough, Chillesford, Sudbourn, Orford, Butley, Sutton, Ramsholt, Felixstow, and many other localities in Suffolk, also from Walton-on-the-Naze in Essex. The specimens so collected were employed by Mr. Searles Wood in the preparation of his Monograph on the Crag Mollusca, published by the Palæontographical Society (1848–1861); with supplements in 1871, 1873, and 1879, illustrated by seventy-one quarto plates. Each figured specimen is indicated by having a small green label affixed to it.

A geological description of the Crag formation by Mr. S. V. Wood, jun., F.G.S., and Mr. F. W. Harmer, was issued by the Palæontographical Society in 1871 and 1873.

The collection was presented by Mr. S. V. Wood to the British Museum, January, 1856, and a supplementary collection was given by Mrs. Searles V. Wood in 1885.

The next "Palæontographical Collection" is of nearly equal antiquity and fully of equal merit. It is the Eocene Molluscan Collection formed by the late Frederick E. Edwards, F.G.S., about the year 1835, and was continually being added to, until a few years before his death, which happened in 1875. It was acquired for the nation by purchase in 1873.

Originally intended to illustrate the fossils of the London Clay, Mr. Edwards extended his researches over the Eocene strata of Sussex, Hampshire and the Isle of Wight, where, assisted by Mr.

Henry Keeping, he made the most complete collection ever attempted by any geologist, and it still remains unrivalled.

Mr. Edwards contributed six Memoirs to the Palæontographical Society, 1848-1856, also separate papers to the "London Geological Magazine," 1846, the "Geologist," 1860, and the "Geological Magazine," 1865, descriptive of the Eocene Mollusca in his collection.

Mr. S. V. Wood continued the work for Mr. Edwards, describing and figuring the "Eocene Bivalves" in the annual volumes of the Palæontographical Society for 1859, 1862, 1870, and 1877. Each specimen which has been figured is specially marked.

About 500 species have been described and figured, but the collection is very rich in new and undescribed forms.

The last Collection is that of a Naturalist who devoted his entire life to the study and illustration of a single class of organisms, namely, the Brachiopoda. It was formed by the late Mr. Thomas Davidson, LL.D., F.R.S., F.G.S., V.P. Pal. Soc., etc., (formerly of 9, Salisbury Road, West Brighton, and Muir-house, Midlothian); between the years 1837 and 1886, with the object of illustrating his great work on the "British Fossil Brachiopoda," published by the Palæontographical Society, in six large quarto volumes, between the years 1850 and 1886, comprising 2290 pages of text, and 234 plates, with 9329 figures, and descriptions of 969 species.

Dr. Davidson was also the author of the Report on the recent Brachiopoda collected by H.M.S. "Challenger" (vol. i. 1880); of the article "Brachiopoda," in the Encyclopædia Britannica, Ninth Edition, 1875; of a Monograph of Recent "Brachiopoda" (Trans. Linnæan Society, 1886 and 1887), and of more than fifty other separate Memoirs mostly bearing upon Brachiopoda both Recent and Fossil, printed in the Transactions and Journals of the various learned Societies, etc.

His collection, both of Recent and Fossil Brachiopoda, together with all Dr. Davidson's original drawings, his numerous books and pamphlets were presented by him to the British Museum through his son William Davidson, Esq., February, 1886. By his direction the entire collection of recent and fossil species *are to be kept together in one series*, for the convenience of reference of all men of science who may wish to consult the same.

At the conclusion of Dr. Woodward's remarks Mr. William Topley, F.G.S., kindly added some valuable information with reference to William Smith's maps and sections and his geological work in various parts of England.

The President then returned thanks to Dr. Woodward, and expressed the interest which, he said, he and all the members present felt in this very important addition made to the exhibition-series of the Galleries devoted to Geology and Palæontology. After a further examination of the Collections the Members separated, well pleased with their visit to this deservedly popular Museum.

CORRESPONDENCE

RECENT DISCOVERIES IN THE SALT RANGE OF THE PUNJAB.

Sir,—Having already trespassed upon your space with regard to this subject, I beg leave to add a few necessary words, because the discoveries already noticed (Geol. Mag. March and May, 1886) have since extended to further recognition, by Dr. Warth and Mr. R. D. Oldham, of the continuation of the boulder beds of the original "Olive Group" westwards—these being identified by their *Conularia*-containing pebble layer in a position entirely different from that which my own acquaintance with the Range would have led me to expect.

My contention has been that the boulder beds with the *Conularia* layer in the east of the Range, occupying a position immediately beneath the Eocene limestone, occupied a different horizon from that of other boulder beds of somewhat similar and somewhat different character, in the west of the Range, which had their place with the lowest members of the series amongst Silurian or other old Palæozoic rocks.

The recent discovery of the same *Conularia*-layer underlying a group of sandstones, next below the Carboniferous Limestone, must modify my previous views, and I feel the more inclined to abandon the contention above stated, were it even to involve identification of the eastern and western boulder-beds as upon one and the same horizon, in consequence of the probability that a coincident unconformity, till quite lately undetected, intervenes between these boulder beds and the older groups of the Range, its place being traceable by means of the boulder-beds with *Conularia* pebbles.

Without the evidence of the subsequently-discovered fossiliferous layer, or that of the associated discordance, the extension of a part of the original "Olive Group" westwards at the higher level appears to have been taken by me as representative of the whole, there being another dark-coloured zone amongst the lower groups, to which soft dark rocks could be referred when low down in the series.

The correction which it is expected will now be applied to previous classifications of the Salt Range rocks is of great interest in connexion with the geology of the Punjab, and I refer to it, so far as my own published views to the contrary are concerned, gladly accepting new light thrown upon the subject from reliable sources, but as far as possible refraining from forestalling the full announcement of details to be looked for from those who have added these important discoveries to our knowledge of the Salt Range series, a series of such complexity that additional facts of detail cropping up here or there might almost have been anticipated. A. B. Wynne.

June 10th, 1887.

P.S.—Since writing the above I have seen Dr. Warth's account of his discovery alluded to (Records Geol. Surv. Ind. vol. xx. pt. 2, p. 117), and find therein much with which I can agree.

THE PALÆONTOGRAPHICAL SOCIETY.

Sir,—By the publication of the Council's Report in your last Number, the attention of your readers is once more drawn to the Palæontographical Society, and its need of a larger number of members in order to find the necessary funds for carrying on its excellent work.

I think I shall be doing the Society a service if I briefly point out some facts which may partly account for the falling off in the number of its members. The Council regret that "geologists in general" do not more readily enroll themselves as members, and they remark that since the formation of the Society, many free libraries, local geological societies, and field clubs have been established, "but that the number of these institutions that have joined the Society is very small."

I venture to think that one reason of this backwardness may be a feeling that the subjects of the Monographs issued by the Society are not always of general geological interest, and that many of them are not such as would be practically useful to the members of local societies.

It is said that a guinea a year is very little to pay for such a splendid series of books, and so it is; but if the intending subscriber feels that half the contents of the volumes are not likely to be of use to him (or to the society he represents), he is apt to think that the money could be more usefully spent in other ways, or perhaps he purchases second-hand copies of those monographs which he does find are frequently wanted, such as Davidson's Brachiopoda, Wright's Echinoderms and Ammonites, Wood's Crag Mollusca, etc., etc.

I feel a difficulty in expressing my meaning more plainly without appearing to depreciate the value of many excellent and valuable monographs which have been published by the Society; but every one admits that there are certain classes of fossils which are of great practical use to the geologist, and that there are others which are of much less geological importance, though biologically they may be equally interesting. In the first category we place the *Mollusca*, *Brachiopoda*, *Echinodermata*, *Corals*, and certain orders of *Crustacea*; among the less useful we must class *Plants*, *Sponges*, *Cirripeds*, *Entomostraca*, *Polyzoa*, *Insects*, *Fishes*, *Reptiles*, *Birds*, and *Mammals*. This being so, it is surely desirable that prominence should be given to the more important groups, and until these have been fully described and figured, very little space should be given to those of less general value; particularly should the delineation of large Vertebrate remains be postponed in favour of the Invertebrate fossils, which occupy so much less space, and a knowledge of which is so much more generally useful.

I know that there are difficulties in the way of applying these principles, and probably the Council would not consider themselves justified in refusing an offered monograph because it deals with one of the less geologically important classes, but I think they should have regard to the effect which the publication of such monographs may have on intending subscribers. Let us consider the monographs

in the recently issued volume for 1886. I imagine there are very few *general geologists* who desire to possess 15 plates of one species of plant, however curious and interesting that plant may be. Again, the appearance of seven plates devoted to the horns of Deer is not likely to be welcomed by any but a few experts. These 22 plates would have illustrated 50 or 100 species of Mollusca, and there are many hundreds of such fossils awaiting illustration.

Why are the Mollusca so neglected? It is true that in this volume we have the first parts of two memoirs on Jurassic Mollusca, but one of these parts is wholly taken up with stratigraphical details which, though unquestionably useful, might perhaps have been condensed or printed elsewhere; this, however is a minor point, and every one will welcome Mr. Hudleston's Monograph. Cannot the Council induce other palæontologists to prepare similar monographs on the *Cephalopoda*, *Gasteropoda*, and *Pelecypoda* of the Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Cretaceous, Eocene, and Oligocene formations?

I can testify that the synonomy of some of the commonest Chalk fossils is in the utmost confusion; and that Monographs of the Cretaceous Mollusca would be welcomed by many amateur and professional geologists. When will Mr. Wiltshire give us his promised contribution? I feel sure that if this and other Molluscan Monographs were produced, and if those relating to fossil plants and bones were deferred, the publications of the Society would be used by a much larger number of persons, and consequently that many more geologists and local institutions would decide to become subscribers.

HARWELL, BERKS, *August 5*. A. J. JUKES-BROWNE.

THE GLACIAL DEPOSITS OF SUDBURY, SUFFOLK.

SIR,—I owe an apology to Mr. Jukes-Browne for having omitted any reference to the action of coast-ice in my paper upon the Glacial Deposits of Sudbury in the June Number of the MAGAZINE (pp. 262-270). In considering the suggestions made to account for the contortion of drift deposits, I should have mentioned the grounding of true or false icebergs, *or of coast-ice*. Nevertheless, it seems to me that the arguments I brought forward against the contortion having been produced by icebergs apply equally to the case of coast-ice.

Unless we are prepared to admit that the drifts were actually frozen into the coast-ice at the time that the contortion was produced in them (and I fail to see how such could be the case, considering the uniformity of succession and characters of the drift over a considerable area), we must suppose that they were deposited on the sea-floor before the exertion of pressure by this ice. If so, it is difficult to see why the drifts were not frozen as well as the underlying Tertiary rocks, for these drifts are of some thickness, and considerable time must have elapsed during their formation. If they were so frozen, the Tertiary beds ought to be affected in the same manner as the drifts, which is not the case.

If the drifts were not frozen, I cannot understand the production in them of overfolds of considerable horizontal extent (such as that shown at the south end of Mr. Green's pit), without any obliteration of the planes of deposition.

Mr. Jukes-Browne speaks of the drifts as being pushed along in a 'partially-frozen state.' Even if contortion can be produced by coast-ice in deposits under such conditions, I cannot conceive that the order of succession of the deposits should be so constant as it is in the Sudbury area, upon this hypothesis. Surely the incoherent portions of the drift would become churned up, so that we should find masses of boulder-clay, gravel, and loam mingled together, and having their divisional planes obliterated. I have seen no signs of such in the area under consideration.

In asserting that contortions occur "in the accumulations which lie on the summits of ridges," I used the term 'summits' not for the highest points, but for the upper portions of the major ridges, and I referred to Mr. Green's pit and the pits near the cemetery. These pits are situated at the upper parts of major ridges, and the contortions are seen in Mr. Green's pit to lie *against* a minor ridge. At the same time I do not wish to assert that all the contortions were caused by the inequalities close to which they now lie.

I regret that my summing up should appear biassed in favour of one explanation. I visited the Sudbury area with little practical knowledge of the East Anglian drifts. Having read much of the literature bearing upon these drifts, including Mr. Jukes-Browne's lucid papers, I started my examination with a strong bias in favour of their marine origin. As I was gradually led to abandon this view, I considered it worth while to state the evidence which weighed with me, but brought forward my reasons as an advocate, and not as a judge. I should certainly not venture to make a charge to a jury with the evidence derived from so limited an area.

I take this opportunity of calling attention to one or two inaccuracies in Fig. 1 of my paper. The Crag mass C should be separated from the filled-in ground D by a little gravel; the junction of the Thanet sand and chalk in the isolated patch at the south end of the pit should be in the same straight line with that of the main portion, and the top and base of the Thanet sand layer are much more even than represented in the diagram.

JOHN E. MARR.

ST. JOHN'S COLL., CAMBRIDGE.
Aug. 6, 1887.

THE CORTLAND ROCKS.

SIR,—Dr. Callaway, in combating the 'metamorphic' origin of the rocks of the 'Cortland Series,' does not appear to be aware that Prof. Dana has materially modified his earlier opinion on this point. After examining some new railway cuttings, he was convinced that the hornblendic and augitic rocks are of true *eruptive* origin, and although he does not find that the new sections throw any light on the origin of the 'soda-granite,' his former line of argument is evidently much weakened (Amer. Journ. Sci. 3, vol. xxviii. p. 384,

1884). Mr. G. H. Williams, who is publishing a series of petrological studies on the whole of the rocks in question, reserves to the last any general conclusions concerning their origin; but he states that the area "is quite sharply separated from the gneisses, mica-schists and limestones which surround it, showing none of the gradual transitions into these rocks which Hermann Credner, in his description of this district written in 1865, supposed to exist." (*Ibid.* 3, xxxi. p. 27, 1886.)

Alfred Harker.

St. John's College, Cambridge, *Aug. 5th*, 1887.

OBITUARY.

SIR J. F. JULIUS VON HAAST.

Sir John Francis Julius von Haast, K.C.M.G., Ph.D., F.R.S., F.L.S., F.G.S., Ord. Fr. Jos., Ord. Coron. Ferr. Austr. Coron. Ital., etc., etc., Director of the Museum, and Professor of Geology in Canterbury College, New Zealand.

It is with deep regret that we learn, through a Reuter's telegram from Wellington, that our friend and fellow-geologist, Sir Julius von Haast, died suddenly of heart disease, on the 15th August. It seems but yesterday that he was here with us, and although complaining of rheumatic gout, which he attributed to the severe work and endless engagements arising out of the duties he was called upon to fulfil last year, as Commissioner in charge of the New Zealand exhibits at the Colonial and Indian Exhibition, he appeared to have many more years of good work lying before him.

Sir Julius von Haast has done excellent service to science in New Zealand, not only in connection with its Geology, in which he took an active part, but also in the discovery and collection of remains of the great extinct Wingless Birds of those Islands with which the Museum of Christchurch (N.Z.), and those of nearly all the principal European and American Museums, have been enriched.

Sir Julius received the honour of Knighthood in recognition of his services in connection with the Colonial and Indian Exhibition; but so far back as 1867, he had been elected a Fellow of the Royal Society in recognition of his services to science. Upwards of thirty memoirs are credited to him in the Royal Society's list of scientific papers, mostly on the Geology and Extinct Birds of New Zealand. His loss will be keenly felt in the Colony where he has laboured so long and diligently.—H. W.

PROFESSOR LAURENT-GUILLAUME DE KONINCK.

Prof. C. Malaise informs us of the recent death (on 16 July last) of our venerable friend, Prof. de Koninck, For. Memb, Geol. Soc. Lond., late Professor of Chemistry and Palæontology in the University of Liége, Belgium. Prof. de Koninck's labours on the Fauna of the Carboniferous rocks of Belgium, England, Australia, etc., are well known. We hope to give a notice of his life in a later Number.—Edit. Geol. Mag.